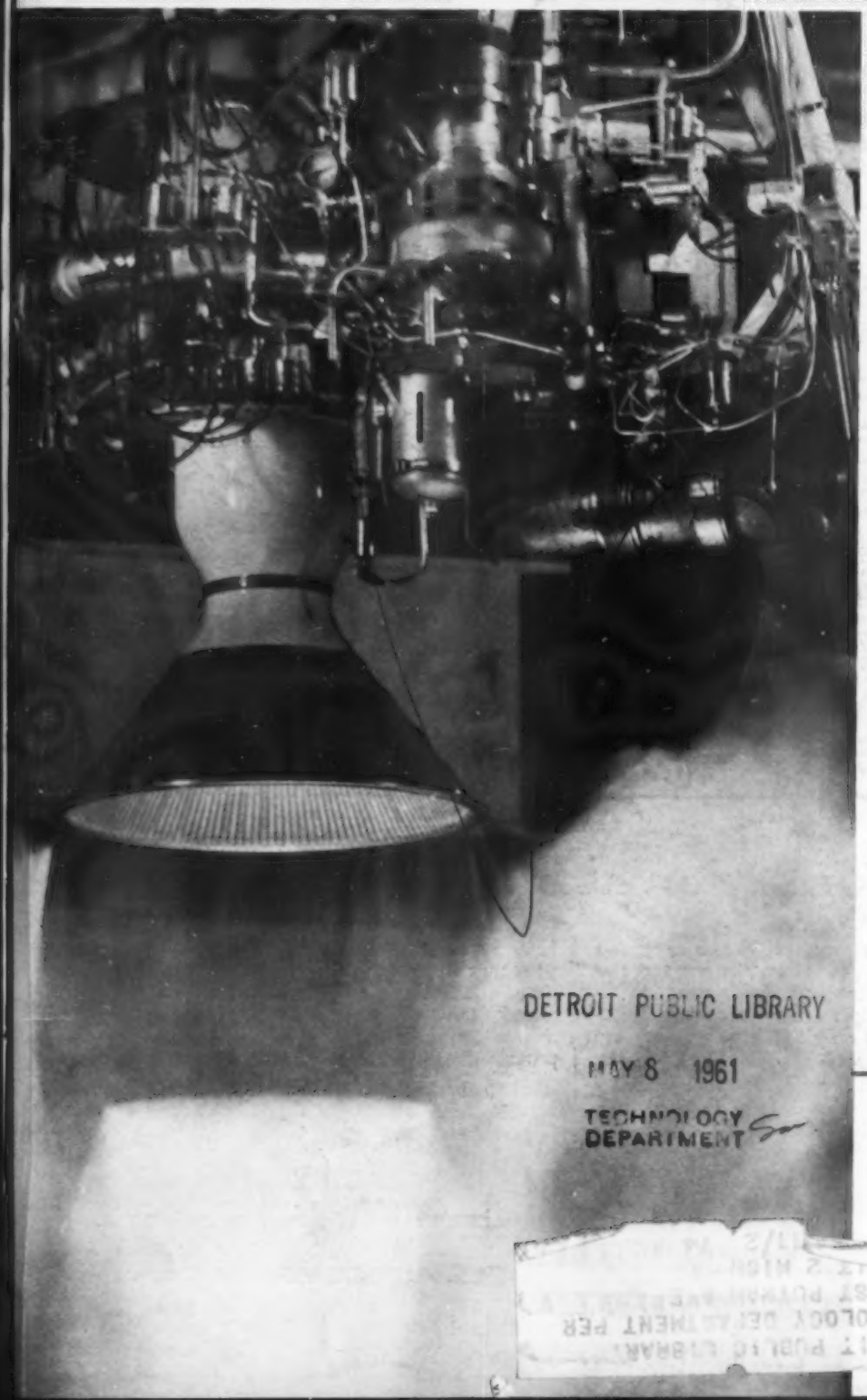
MAY 8, 1961

missiles and rockets

THE MISSILE/SPACE WEEKLY

V8 #19



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TECHNOLOGY DEPARTMENT

U.S.-British Row Could Develop From Skybolt Uncertainty

- MR-3 Launch In Perspective
- Titan to Get 2nd Stage Skirt
- New Edition— M/R's Astrolog

Firing Titan II 2nd Stage

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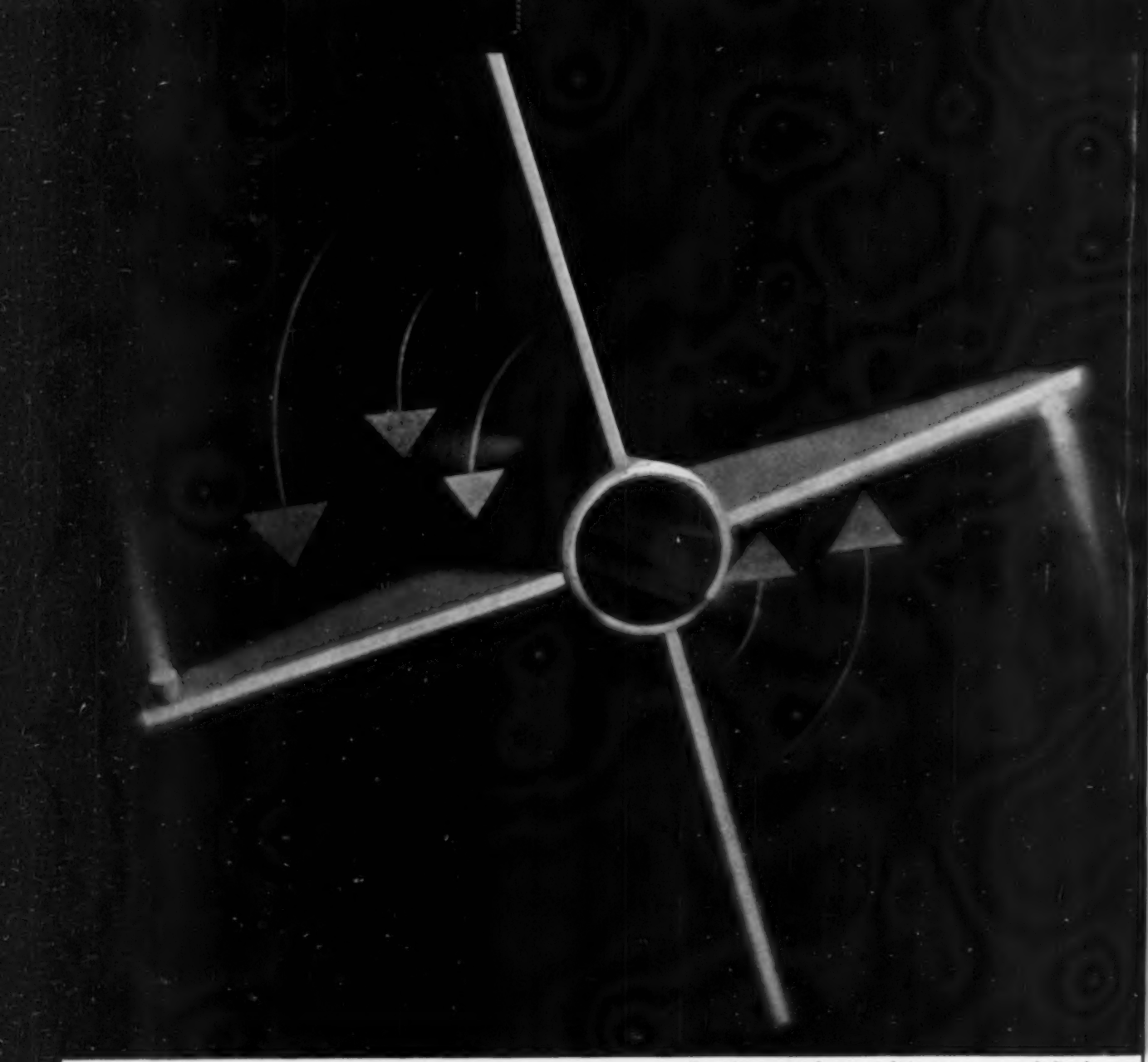

Reaction controls at work in space — symbolized.

STEERING GEAR FOR ASTRONAUTS

Conventional aircraft control surfaces will not guide space ships and capsules. Rudders, ailerons and elevators find no resistance and hence produce no reaction to their movements where there is no atmosphere. Even at altitudes only half way up, they are sluggishly ineffective.

The accepted answer to a dependable steering mechanism for astronauts is a system of jet reaction controls developed and produced by Bell Aerosystems Company. First used on Bell's own supersonic X-1B several years ago, the system has been greatly improved and adopted for the X-15, the Mercury man-in-space project and other space vehicles.

Through strategically located, low and high thrust (1 to 1500 pound) rocket engines, Bell's reaction controls not only position and guide the ship by controlling the roll, pitch and yaw, but they also provide for orbit changes and retro-thrust. Some of the jets are throttleable while others can be operated in combination to provide the astronaut positive and flexible control.

This revolutionary steering gear for space, available using monopropellants or high energy bipropellants, is just one of many advanced projects which are currently engaging the diversified talents of Bell Aerosystems Company in the fields of rocketry, avionics and space techniques. Engineers and scientists seeking challenging, long-range career opportunities can find them at Bell.

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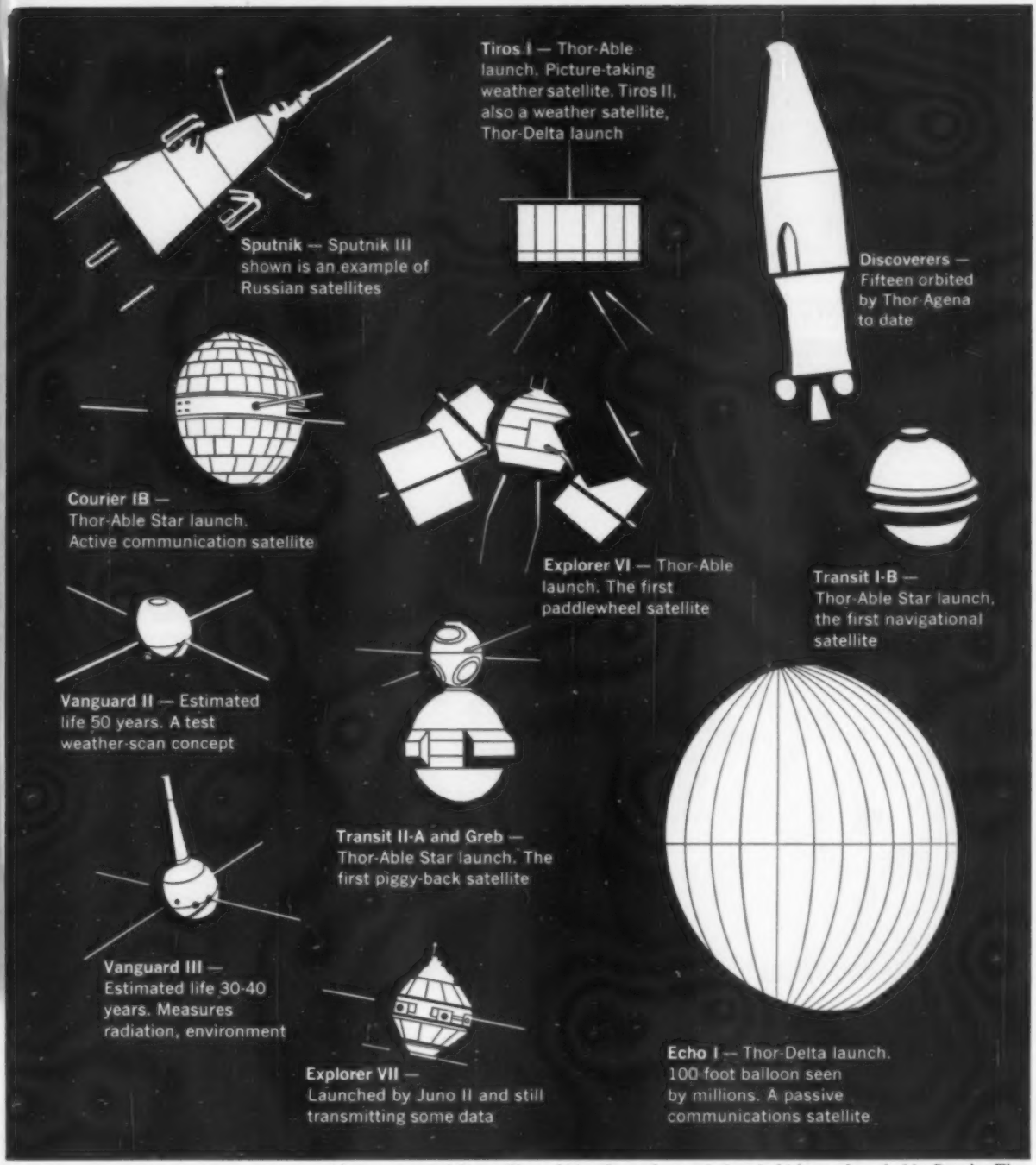
Tiros I — Thor-Able launch. Picture-taking weather satellite. Tiros II, also a weather satellite, Thor-Delta launch
Sputnik — Sputnik III shown is an example of Russian satellites
Discoverers — Fifteen orbited by Thor-Agena to date
Courier IB — Thor-Able Star launch. Active communication satellite
Explorer VI — Thor-Able launch. The first paddlewheel satellite
Transit I-B — Thor-Able Star launch, the first navigational satellite
Vanguard II — Estimated life 50 years. A test weather-scan concept
Transit II-A and Greb — Thor-Able Star launch. The first piggy-back satellite
Vanguard III — Estimated life 30-40 years. Measures radiation, environment
Explorer VII — Launched by Juno II and still transmitting some data
Echo I — Thor-Delta launch. 100-foot balloon seen by millions. A passive communications satellite

Above are some of the satellites orbiting the earth, a majority of which were launched by Douglas Thor

The Douglas Thor rocket has orbited more satellites than all other rockets combined!

Of all satellites put in orbit since 1958, 55% were launched by the Air Force-NASA Thor IRBM. In its last 83 tactical and space firings by the Air Force, Navy and NASA, 86% have been completely successful – a reliability inherited from forty years of Douglas experience in aviation and 21 years in missiles and space.

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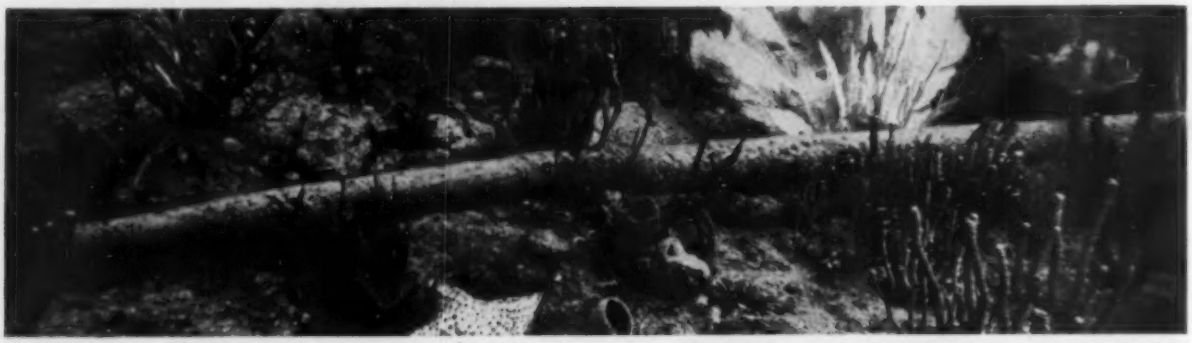
from the reaches of space

Unretouched time exposure shows Echo I communications satellite (long line) crossing heavens right to left. Shorter lines are stars "in motion."



to the depths of the sea

Actual undersea photo of telephone cable off coast of Florida.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 8, Number 19 May 8, 1961

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THE COVER

Titan II second-stage engine is test-fired at Aerojet-General's Sacramento plant. An ablative skirt will be added to the thrust chamber before flight. See report on p. 22.

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Designed for strapdown control applications, this miniature wide angle precision gyro provides accurate and reliable performance in extreme missile environments.

A newly developed high viscosity damping fluid with good low temperature characteristics permits large angular inputs without loss of reference and eliminates the need for paddle type damping devices. Low uncompensated drift levels are obtained through the use of externally controlled adjustments of mechanical mass unbalance and fixed torque drift. A unique torquer with external adjustments makes possible high torque linearity including at the "off null" position. The spin motor will operate satisfactorily from a three phase or single phase 400 cps power supply.

Actual test data taken on a group of these gyros demonstrate the capability of this device as the most accurate and stable control gyro now available. Typical test results include the following average values:

Uncompensated mass unbalance level—0.35°/hr/g avg.; Uncompensated restraint level—0.4°/hr avg.; Torquer linearity 0.017% avg. proportional from 0.1°/sec to 5°/sec.

TYPICAL CHARACTERISTICS

Angular momentum (gm cm²/sec.)		100,000
Operating temperature		180°F*
Torquer scale factor (°/hr/ma)		800
Input angle		Up to 30 degrees
Transfer function (mv/mr)		3.75 at gyro gain of 3.0
Dimensions:	**lengths**	3.56"
	body diameter	1.98"
	mounting diameter	2.15"
Weight		1.2 pounds

*lower operating temperature as required

Write for complete data

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letters

The Long Sleep

To the Editor:

The statement ". . . we are all asleep," by Lt. Col. Powers (press officer for the U.S. astronauts, when asked in the early morning hours to comment on the Soviet manned launching) in M/R, April 17, p. 15, seems to accurately reflect the attitude of the country with respect to space, missiles, and civil defense. How about reviving "Countdown for Survival," which started off so well in the Oct. 3, 1960, issue of M/R? It might help to wake the sleepers.

David W. Johnston
Washington, D.C.

Missile Safety Courses

To the Editor:

The Aviation and Missile Safety Division of the University of Southern California was quite interested in the reaction (Letters, M/R, April 24, p. 52) of Mr. Ickes, manager of public relations for Aerojet-General Corp., to the announcement of our formal course in missile safety.

The chronological establishment of safety courses is of no practical significance. To be sure, there have been missile safety courses which originated prior to courses conducted at either Aerojet or USC. To allay any false conclusions which may result from Mr. Ickes' letter, we feel it is important to define the purposes of various courses of instruction. A training course is designed to improve one's skill or mechanical ability. The purpose of an educational course is to increase knowledge. Obviously, some knowledge must be imparted in a training course, but this is not the *prime* consideration, as it is in the case of an educational course.

The philosophy behind all the safety courses taught at USC has been the imparting of technical knowledge with examples of specific safety application. The advantage of this philosophy is that a technically educated person will be able to recognize dangerous conditions and take corrective action before an accident may occur. He is also in a better position to successfully determine the *actual* cause of an accident if one does occur and preclude its reoccurrence.

Safety training, on the other hand, only teaches the causes of past accidents; it requires a disastrous history of failures to achieve its goal. The prevalence of this philosophy is evidenced regularly in newspaper accounts of attempted launchings.

A mute consequence of the safety "educational" philosophy is a more effective and reliable weapon system, which is the real purpose of missile safety in the first place. This fact is just beginning to be appreciated.

In these respects, we feel that the Aviation and Missile Safety Division is unique, as is the formal course in missile safety.

Eugene Dimitruk
Lecturer, Aeronautical Engineering
Aviation and Missile Safety Div.
University of Southern California
Los Angeles

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The Countdown

WASHINGTON

Cuba: A Coming Missile Threat?

Some top military men are more worried than ever that Premier Castro's next step in Cuba will be to "import" some Soviet-made missiles. These could be used to terrorize much of Central America—possibly they would be used as a blackmail threat aimed at Miami.

Skybolt Moves Forward

The *Skybolt* ALBM program, rejuvenated at least in part by the Kennedy Administration, is moving forward almost precisely on its original schedule again. B-52 H and RAF Vulcan jet bombers are expected to begin air-dropping the first inert *Skybolts* this summer. Bombers are expected to begin dropping the missiles for hot launchings about next spring. (See page 10.)

No News Is Good News

The Administration is pushing ahead with its plans to stanch the flow of information about U.S. military programs. The Administration argument: Even if the information can't be kept from the Russians if they want it, why make it easier for the Russians to get it. Counter-argument being made: Easy or not, the Russians will get it. The government and the Russians will know—only the voters won't.

Red Missiles May Send SAC to Ice Cap

The Air Force may use remote ice runways in the Arctic for dispersing SAC bombers in the face of the growing stockpile of Soviet ICBM's. A 14,000-foot test runway capable of handling B-52 bombers and missile-packing Century Series jet interceptors has already been built in North Star Bay, Greenland.

Polaris Relay Ship Being Built

The Navy is converting a carrier into a major communication relay ship that could serve among other missions as a key command link with the submerged *Polaris* fleet. The big ship could be used as the relay point for an order to launch if the Navy's land-based *Polaris* transmitters were knocked out.

INDUSTRY

G-D Reorganizing

Missile/space activities and electronics are getting much heavier emphasis in a large-scale reorganization of General Dynamics Corp. Convair-Astronautics will have a new role as a separate division with aircraft activities grouped in what is now the Convair Division. Major management functions headquartered in the San Diego corporate office of Convair are due for transfer to G-D New York offices.

$12 Million More for 3059

Watch for the Air Force to award a $12-million follow-on contract for development of the 1-million-lb.-thrust solid-fueled *Project 3059* booster. Aerojet-General, the prime, has been working on the big rocket under a $4-million contract. The total amount for *3059*, incidentally, almost equals the $15-million increment NASA is asking in the FY '62 budget for solid fuel research.

Polaris A-3 Contract Coming

Navy's Special Projects is due soon to let a hotly-contested multimillion award for the second stage of the 2500-mile *Polaris A-3*. Big question is whether the Navy will buy a filament-wound glass motor case. Hercules Powder has dominated the field. But Aerojet-General recently has acquired a substantial capability in this new technology, along with Grand Central Rocket, in winding filament directly on propellant.

R&D Intelligence

Low-speed tests of a "paraglider" recovery system for the *Saturn C-2* are under way at NASA's Langley Research Center. The 1/6 scale model was developed by North American Aviation's Space and Information Systems Division. . . . Wide-angle camera (880 sq.-mi.-range) aboard *Tiros II* is now taking satisfactory pictures of cloud cover. Trouble with the lens, which was coated by some material during outgassing, has cleared up. . . . One engineer close to the *X-15* says the delayed motor ignitions during the last two flights probably were caused by pilot errors, since there were no failures until ignition prerogative was given to the pilot.

INTERNATIONAL

Blue Water Unveiling

English Electric is expected to unveil its 100-mi-range *Blue Water* May 16 in Britain before taking it to the Paris Air show 10 days later. The British are engaged in a big campaign to sell this solid-fueled tactical missile to NATO.

Pershing to Germany?

COUNTDOWN is told the chances are good West Germany will buy the 350-mile-range *Pershing* tactical missile. Recently, a German delegation of defense officials and Secretary of State Hopf visited Martin-Orlando and reportedly went home impressed with *Pershing*.

Overseas Pipeline

Quelling of the Algerian revolt is believed to have kept France from withdrawing from the European Space Club. . . . Germany may make its decision on joining the club in two weeks. . . . There's a rumor aloft that British scientists may have scored a "breakthrough" in the anti-missile race.

Yuri's Flight Details

Russia soon will submit details of Yuri Gagarin's orbital ride to the Fédération Aéronautique Internationale to claim records for space flight. Details said to be forthcoming: type of rocket engines and configuration, total thrust, launch site, special apparatus used to recover the flight vehicle, how the landing was made and where.

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The Missile/Space Week

Shots of the Week:

The Air Force successfully launched a *Titan* missile directly from a silo in a test of the *Titan II* launch pad configuration.

The missile, a *Titan I* with no second-stage separation or ignition, was destroyed by Naval range safety officers who requested the unnecessary destruction as a test of their facilities.

The launch, called "completely successful," was billed as the final check of a concept designed to reduce reaction time from 15 minutes to a few seconds. Everything in, around and above the silo was wired for collecting data on acoustics, heat and atmospheric pressure that rode out with the missile as it rose from the silo launch test facility. The test provided data on whether the *Titan* in the silo could withstand the acoustics, temperatures in excess of 5000°F, and pressure during the 8 seconds before it emerges from its silo after first-stage ignition.

The launch also checked the missile to the theoretical limits of its structural strength by continuing strong programing signals to the autopilot beyond T+96 seconds.

The bird was allowed to fly for 140 seconds, then destroyed. It reached about 200,000 ft. altitude and 15 miles distance.

The silo-lift method will be used for the first six *Titan* squadrons. *Titan II* squadrons, using the in-silo facility, will enter the Air Force inventory starting with the seventh squadron.

At Eglin: A *Bomarc B* missile intercepted and destroyed a *Regulus II* target missile streaking at Mach 2, 50,000 feet over the Gulf of Mexico.

At Canaveral: An advanced *Polaris A2X* launched from a land-based pad flew more than 1400 nautical miles.

Morse Stepping Down

Assistant Army Secretary Richard S. Morse, has submitted his resignation to be effective June 1.

The resignation is in line with a decision announced privately several months ago. No successor has been named.

Add Contracts

A $4.8-million contract for final design of a *Saturn* static test stand at Huntsville was awarded by NASA to Aetron, a division of Aerojet-General.

The contract includes procurement and fabrication of technical

S-15 Goes to Work

GAMMA-RAY astronomy satellite (S-15) is lowered into shroud covering upper stages of a Juno II test vehicle preparatory to successful launch late last month. Experiment's objectives are to detect high-energy gamma rays from cosmic sources (such as from our own galaxy and neighboring galaxies including the Magellanic clouds) and map their distribution in the sky. (See M/R, April 3, p. 19, and Feb. 6, p. 24.) Six hours after launch, S-15 began collecting and telemetering data to Minitrack stations. On May 2, period was 108 minutes; apogee, 1111 statute miles; perigee, 301 statute miles; inclination, 28.8°; and estimated life in orbit, 13 months.

systems and instrumentation for the $10.8 million facility.

Sperry Gyroscope received a $33-million contract for production of guidance systems for the Navy's *Terrier* missile.

Vostok Still Under Wraps

Although the Russians were still trumpeting their man-in-space accomplishment for propaganda purposes, no specific facts emerged on whether it was a winged or capsule-type vehicle.

The party-line newspaper *Isvestia* said only that descent began 5000 miles from the landing point, and took about 30 minutes—prompting speculation that it was a vehicle with aerodynamic surfaces.

It also noted that provisions were made for the pilot to land in the cabin or, if necessary, parachute out in an ejection seat. Which was done in the case of Gagarin remains a mystery.

One significant detail now claimed by the Soviets: Gagarin could have, if necessary, controlled all the instruments on board the ship even though they were preprogramed.

ICBM's Sit Out May Day

May Day was ushered in at Red Square by an impressive array of heavy artillery and tactical weapons but larger weapons of the ICBM class were conspicuously absent.

Biggest of the missiles paraded publicly were estimated by Western observers to be IRBM's with ranges of about 700 miles. All appeared to have been shown in previous May 1 parades.

Although the armaments portion of the parade was the shortest in recent years, lasting about 22 minutes, the speeches emphasized the Soviets' military might. Defense Minister Rodion Malinovsky said the Soviet Union was strengthening "still further" its armed forces and defense capacity.

Soviet cosmonaut Major Yuri Gagarin held a place of honor next to Premier Khrushchev on the reviewing platform.

Boeing Drops 'Airplane'

Boeing Airplane Co., following the lead of a number of other major missile manufacturers, is dropping the "airplane" from its longstanding corporate name.

The company posted $5.9 million in first quarter earnings on sales of $325 million. This compared with earnings of $4 million on sales of $396 million the same period last year. Backlog was $2.8 billion, compared with $2.13 billion at March 31 a year ago.

Teaser in Red Square Procession

BIGGEST MISSILE in Russia's Red Square parade on May Day is shown above. While observers said it did not appear to be anything new, there was some speculation that it could be the new T-5A solid-fueled IRBM.

Dyna-Soar Force Picked

A *Dyna-Soar* test force has been chosen at Edwards AFB to study its operating methods—although no individual pilots have been chosen yet.

Maj. Gen. John W. Carpenter III, commander of the Air Force flight test center, said six pilots, four of them instructors at the school, will start the special course in June.

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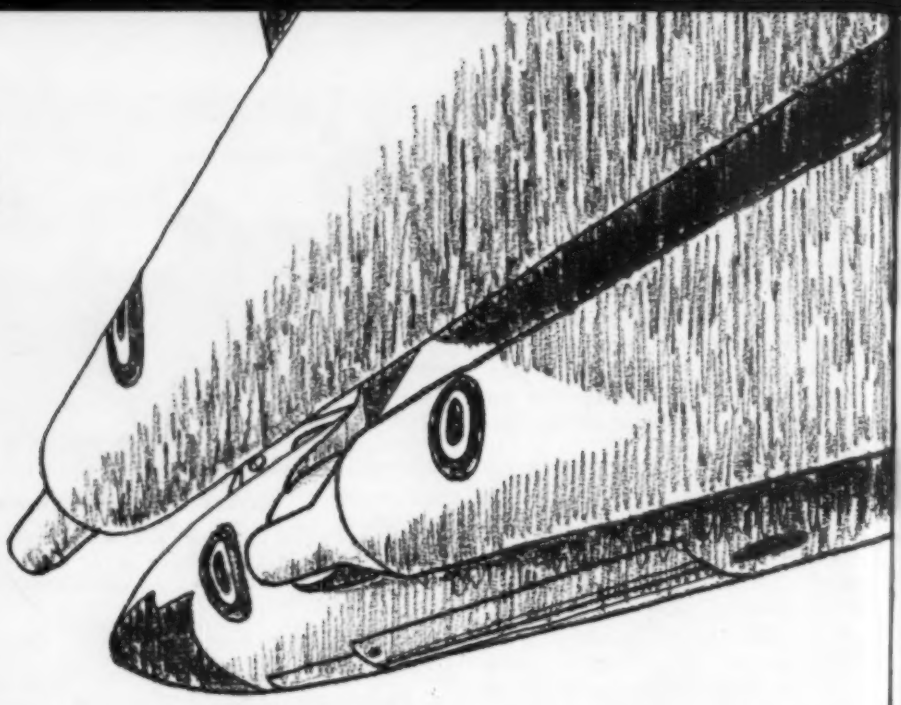


How Skybolts would look attached to the wings of Britain's Vulcan bomber

U.K.'s strategy is based on delivery by U.S. in mid-60's

Skybolt Uncertainty Haunts British

by James Baar

LONDON — The Kennedy Administration is allowing the *Skybolt* ALBM to become a potential time bomb at the heart of Anglo-American relations.

As of today the 1000-mile range air-to-surface missile continues to be the key nuclear weapon in RAF planning for the last half of the 1960's despite strong political opposition in Britain.

However, unknown to the British public and certainly many British leaders, the *Skybolt* R&D program was all but shelved by the final Eisenhower defense budget. And, under the Kennedy Administration, *Skybolt* has fared only a little better.

Skybolt originally was scheduled to become operational in 1964 when the Air Force directed Douglas Aircraft Corp. to proceed with the R&D program on Feb. 17, 1960.

The Administration authorized the obligation of $80 million for the program in FY '61, a figure which the Air Force considered insufficient to meet the 1964 operational goal. Later, the Administration approved an Air Force plan to increase the funding of *Skybolt* in FY '61 to $150 million.

Meantime, the United States and Britain concluded an agreement under which *Skybolts* would be sold to the British for deployment with RAF V-bombers. The missiles were to be fitted with British nuclear warheads.

• **Does it exist?**—Reaction in Parliament and the British press was loud and cutting.

A typical headline in the London *Daily Express* said: "The Sorry Truth about the Skybolt Deal." A typical Labourite charge made by MP George Brown, Defense Minister in the Labour Shadow Cabinet, was that *Skybolt* did not exist and no one knew when it would.

Behind the charges were three major factors:

—The cancellation of the *Blue Streak* IRBM by the British Government, a move that virtually put the British missile industry out of the big missile business.

—General British chagrin at the idea of tying the major British nuclear force in the late 1960's to an American-made missile.

—The claim by British missile industrialists that they could produce the *Skybolt* themselves.

Defense Minister Harold Watkinson defended the *Skybolt* agreement on the grounds that Britain would get the missile from the United States sooner and cheaper than if a similar weapon were developed by British firms. He also stressed that the *Skybolts* would be purchased outright without any binding strings, thereby maintaining an independent British nuclear force. The Conservative Party's word thus was staked on *Skybolt*.

Then, last December, the Eisenhower Administration cut back the *Skybolt* R&D program. The Air Force was directed to spread the $150 million authorized for FY '61 alone over FY '62 as well.

This meant in the opinion of experts close to the program that there was no chance of the missile being operational in 1964 or possibly even 1965. The stretchout was vaguely indefinite.

• **On a limb**—President Kennedy reversed the Eisenhower decision at least in part. He added $50 million to the program for FY '62.

The Kennedy addition gave the program a fighting chance to meet the 1964 goal, but only if large infusions of money are made over the next two fiscal years. Almost all of the margin for error—almost all insurance—was thrown away.

Moreover, the Kennedy Administration removed at least for the present two future launching platforms for *Skybolt*—the B-70 and the nuclear-powered aircraft. Therefore, the usefulness of the weapon in the United States is accordingly decreased.

Not so in Britain.

The entire British strategic force is being molded toward the development of *Skybolt*. Production of Victor bombers, which cannot be fitted with *Skybolts*, is being cut. The production of Vulcans, which can carry the missiles, is being increased.

By the mid-60's the RAF is expected to have about 200 Vulcans that can be deployed in Britain or dispersed at overseas possessions. They will be waiting to receive their deadly loads of *Skybolts*—without which they will be highly vulnerable to enemy air defenses.

The question is: will the *Skybolts* be ready? ⌗

Senator hits press agents . . .

MR-3's Import Distorted by Publicity

Bad weather scrubs first launching attempt and technical troubles extend delay; McDonnell gets contract for six vehicles

by Jay Holmes

CAPE CANAVERAL—America moved toward its first manned ballistic space shot in an orgy of publicity that threatened last week to obscure the fact that *Mercury Redstone 3*—even if successful—would be only a flea hop compared to Russia's manned orbital flight.

Roughly 500 newsmen jammed the Cape to cover the long-delayed event for newspapers, radio and television. Their arrival a week ago Sunday turned out to be premature.

The shot—scheduled for Tuesday with Astronaut Alan B. Shepard aboard—was scrubbed because of bad weather and rescheduled for later in the week. This left the newsmen with little to do but report the movements of Shepard (who had nothing to do but wait) and interview visiting congressmen and each other.

So great was the fanfare that Sen. John J. Williams (R-Del.) urged the Kennedy Administration to cancel the shot and reschedule it for some undisclosed time—so that "another American fiasco" comparable to what happened in Cuba could be avoided. The senator blamed the big *Mercury* buildup on government press agents—most of them holdovers from the Eisenhower Administration.

"It is long past the time when Administration officials should stop talking about their great plans," Williams declared on the Senate floor, "and devote more of their efforts toward constructive work in getting their job done."

Newsmen on their toes at the Cape promptly asked Chairman Overton Brooks (D-La.) and 16 members of his House Space Committee who had journeyed here for the occasion what they thought about the burning publicity issue. The reaction was mixed.

Said Brooks: "What's wrong with it?" He obligingly posed for pictures with Shepard.

Said Sen. Howard W. Cannon (D-Nev.) of the Senate Space Committee, who flew in for a day in a T-33 jet trainer: "I don't see why we have to make it such a major production, particularly when there are so many things that can go wrong. . . ."

Others generally agreed that in a free society, with a free press, the buildup to the shot was inevitable.

• **Countdown begins**—The *MR-3* operation required that there be no more than an 18-knot wind, 3-ft. waves maximum and no more than 40% cloud cover over the recovery area 290 miles downrange. The weather forecast on Tuesday called for a squall line to move through the Cape area during the night, with a 50-50 chance the skies would clear a few hours after daybreak to the required condition.

Mercury Operations Director Walter C. Williams decided to take the chance on Monday and the countdown proceeded normally for launching the 2500-lb. bell-shaped capsule. The final phase, 390-min. countdown began at 12:30 a.m. Tuesday. It proceeded until T-290, when the storm broke over the launch pad and a hold was called. The count was resumed at 3:50 a.m.

The 37-year-old Shepard, who had been awakened at 2 a.m. along with his backup, Lt. Col. John H. Glenn, breakfasted and went through a physical exam. Four sensors and a respiration gauge were attached to his body and a wired thermometer was inserted in his rectum. Shepard then donned his pressure suit, a 15-minute operation requiring the help of a technician.

He remained in Hangar S, five miles from the pad situated not far from the Banana River. Shepard asked Glenn to inspect the interior of the capsule for him and a hold was called at 4:15. However, for some undisclosed reason, Glenn did not make the inspection and the count was resumed at 4:27. There was another four-min. hold at 4:51.

The plan was for Shepard to leave Hangar S and enter a special transfer van at T-185. During that time, a new weather report showed conditions had worsened. Shepard remained in his quarters. The count continued to T-140 as the storm moved out to sea. Skies were partially clear over the Cape at 6:30 a.m.

There was another hold to 7 a.m., when word came that rain was falling heavily at Grand Bahama Island 75

ASTRONAUT Alan Shepard was told three weeks ago he would take MR-3 ride—then found out he had to wait.

miles southwest of the recovery area. Williams thereupon scrubbed the shot.

The minimum recycling time was announced as 48 hrs. However, because of a series of minor technical difficulties, and the need of a complete booster-capsule check, Williams ordered the launching delayed until at least Friday. During the LOX purge, a small tube snapped on the *Redstone* and had to be replaced. Also, one of the EKG biomedical telemetry circuits in the capsule acted up.

Williams told reporters that if weather should be bad on Friday, a Saturday launching would be possible, but if a second recycling should be required after pumping LOX in on Friday, workers at the Cape would be given Sunday off and the count would be resumed Monday for a Tuesday launch.

During flight preparations it was announced that McDonnell Aircraft Corp., prime to NASA for the *Mercury* capsule, had received a contract for six Mark II *Mercury* vehicles with a preliminary expenditure limit of $2.5 million.

• **Some contributors**—Information also was made available on contributions to the program by some of McDonnell's 2000 subcontractors. Here are a few:

• Radioplane Division, Northrop Corp.—Developed and tested the parachute landing system, which consists of a 6-ft.-diameter conical-ribbon drogue chute, designed to deploy at 21,000 ft. altitude to stabilize and decelerate the vehicle to 160 knots true air speed, and a 63-ft.-diameter ringsail main chute, designed to open first to 10 ft. diameter for four sec. and then all the way, to reduce speed to 30 ft./sec. A second main chute is installed as backup.

Radar chaff is ejected when the drogue chute deploys. On main chute deployment a Sofar (Sound fixing and ranging) bomb falls into the ocean and explodes to help the Navy find the capsule in a hurry. On impact, a dye marker is released to aid the visible search. The dye includes shark repellent.

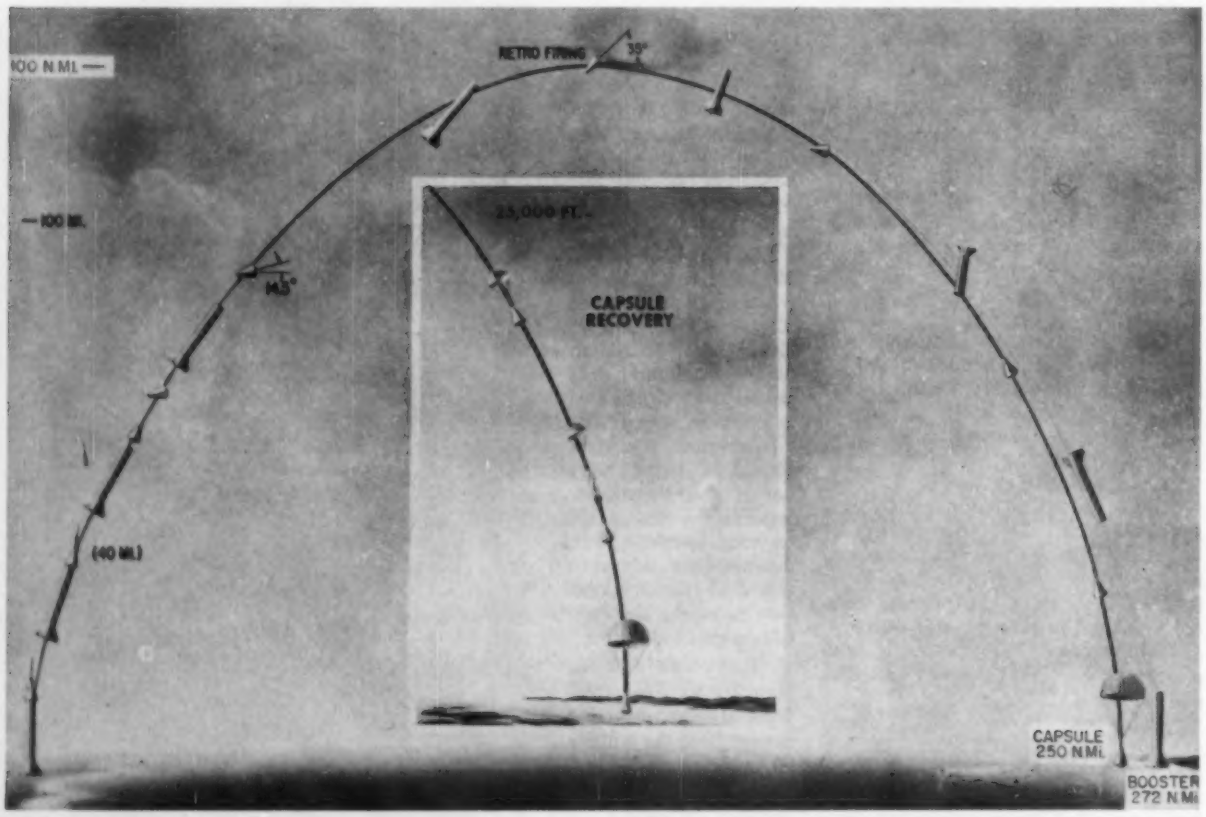
• Minneapolis Honeywell, Military Products Group—Developed two major capsule systems, three other components and two major GSE items. The attitude stabilization and control system, gyro-referenced, generates command signals to hydrogen peroxide jets that maintain capsule in desired orbital position and position it properly for re-entry. The attitude and rate-indicating system gyroscopically senses attitude and gives the astronaut a roll-pitch-yaw visual indication necessary for manual control.

The earth-path indicator is a dead-reckoning computer that continually shows astronaut his position and where he would land if ejected from orbit. The humidity indicator senses conditions in capsule interior. The explosive release system for the escape hatch allows severing of bolts holding the hatch, if desired after the capsule impacts or while it is being picked up by helicopter.

GSE items are a hydrogen peroxide servicing trailer and checkout equipment for the attitude stabilization and control system. Honeywell also conducted considerable human factors research.

• Atlantic Research Corp.—Provided two types of solid-propellant rockets. The larger rocket, generating 860 lbs. of thrust for 1½ sec., jettisons the escape rocket superstructure either after use to allow parachute deployment or after booster burnout, when the escape rockets are no longer needed. The smaller rocket, generating about 415 lbs. thrust for a fraction of a second, is used in a cluster of three—called the posigrade package—to pull capsule forward from booster after separation.

• Thiokol Chemical Corp., Elkton Div.—Provided cluster of three retro rockets 15.5 in. long and 12 in. in diameter with fiberglass-plastic nozzles. Heater blankets keep rocket motors warm during assembly on launch pad so as to limit temperature range during flight and increase reliability. ⌗



MR-3 FLIGHT PATH will take astronaut to altitude of 115 mi. and distance of 290 mi. Time-in-flight will be 15.5 min.—with g-loadings of 6 during launch and 11 during re-entry. Weightlessness will last 5 min. at apogee of trajectory.

On Capitol Hill . . .

Relatively Small Budget Boosts Urged

House groups add funds for more missile-carrying planes and ships and modest increase for NASA; Senate panel told of costly labor troubles

HOUSE COMMITTEES this week put themselves on record as favoring only relatively minor increases in Administration budget requests for the Defense Department and space.

Meantime, the Senate Investigations Subcommittee continued to open to the public the record of labor walk-outs, strikes and slow-downs that have cost the Air Force ICBM base-building and missile programs months in lost time and millions of dollars.

The House committees' actions did not give encouragement to advocates of large increments to the U.S. missile and space programs.

Usually maximum increases to authorization bills are made in the House and trimmed in the Senate. However, this year the pattern may be reversed—at least in connection with the space program.

The White House is expected to make some recommendations—possibly sizable ones—for an increased space effort in the near future. The Senate Space Committee is waiting for them before acting on the NASA authorization bill.

• **Some additions**—The House Armed Services Committee approved a defense authorization bill that left President Kennedy's request for $3.4 billion for missile procurement unchanged.

However, the committee added $337 million for procurement of 15 more B-52 missile-carrying bombers and 16 B-58's, reversing the Eisenhower-Kennedy budget decision to end procurement of Air Force bombers entirely. The increase brought to nearly $5.5 billion the procurement authorization for all military aircraft.

The committee also added $10 million to the Navy's $2.9 billion shipbuilding authorization and directed that the addition be used along with requested funds for three conventionally powered missile frigates to build two nuclear-powered missile frigates instead.

The House Space Committee added $88.7 million to the $1.2 billion requested by Kennedy for NASA—still nearly $100 million less than NASA sought from the White House earlier this year.

The committee voted the extra authorizations and announced them before completing action on the entire bill. But several members said no further sizable increases are expected.

Earlier, there had been talk in the committee of boosting the NASA budget to $1.5 billion or higher. Some members also had hoped for White House support for new major increases in the light of the Soviet triumph of launching the first man into orbit last month.

The biggest slice of the committee-approved increase went to *Apollo*—NASA's proposed post-*Mercury* man-in-space program.

Apollo received $50.2 million, boosting its authorization to $79.7 million. The breakdown of the addition: $42.6 million for additional high-speed reentry research and other related projects, $5 million for advanced tracking facilities and $2.6 million for salaries. It was not immediately apparent whether any of the money would be used for hardware.

The committee added $23.5 million to the *Rover* nuclear booster R&D program: $8.5 million for long-lead-time non-nuclear rocket components and $15 million for construction of an additional engine test stand in Nevada. The increase brought the total NASA *Rover* authorization to $51.5 million.

Finally, the committee added $15 million to the bill for solid propellant research. This was all that NASA would agree that it could use, despite committee urging.

• **Unions assailed**—The Senate Investigations Subcommittee called representatives of both management and labor to testify on the rash of labor troubles that has plagued missile bases and test sites.

One contractor—Henry Gable, president of Gable Electric Service of Dallas, Texas—said labor slow-downs, walkouts and strikes have done more harm to U.S. missile programs at Cape Canaveral than the Communists ever could do.

He specifically aimed his attack at Local 756 of the International Brotherhood of Electrical Workers at the Cape. However, he praised the IBEW national union. He said it did not approve of the local's actions.

Subcommittee Chairman John McClellan said the local union's behavior "borders almost on subversion."

Max Lasky, administrative contracting officer at the Cape, said "the Electrical Workers, Iron Workers, and Pipe Fitters have been the unions which have caused most labor difficulty at the Cape."

He testified that when he refused to approve overtime for a job that did not require it he received unsolicited sale offers, unordered sod and cinder blocks and abusive phone calls.

Edwin R. Brown, executive secretary of the Central Florida Chapter of Associated General Contractors of America, said that the Air Force and Army have abetted the unions by remaining neutral and pressing contractors to get on with jobs or face contract cancellation.

"The unions in this area have been acting like spoiled children," Brown said. "Although they get everything they want, they still ask for more."

He added that because the military services have refused to intervene, the unions have "shown neither conscience nor patriotism in achieving their own selfish ends."

It was against the background of testimony such as this that the committee learned that a $3.50-an-hour electrician at the Cape made $647 one week because of overtime made necessary by labor difficulties. The subcommittee noted that this was $127 more a week than the salary of Defense Secretary McNamara. ⌗

Key House Committee Budget Boosts

(in millions)

For the Air Force	
15 missile-carrying B-52's	
16 B-58's	*$337*
For the Navy	
2 missile frigates (for nuclear power)	*$10*
For NASA	
Apollo	*$50.2*
Rover	*$23.5*
Solid fuels	*$15*

Fading moon hope...

Overtime Won't Help Speed Saturn

NASA men see no chance of cutting mid-1964 operational date —although big booster is moving toward fall flight

HUNTSVILLE, ALA.—*Saturn*—America's only entry in the race for the moon —is now moving hopefully toward a first flight test this fall. But program managers see no chance of speeding up the big booster's mid-1964 operational date.

They contend that even with the authorization of additional overtime (the average work week is now 47 hrs. with some critical areas ranging up to 54 hrs.) any further compression in the tight schedule leading to the first few flights would be "academic."

Their appraisal generally confirms President Kennedy's gloomy prediction that "*Saturn* is still going to put us well behind . . . regardless of how much money we spend. . . ."

However, some officials connected with the program are optimistic as to how far the U.S. is behind Russia. These officials feel that the American program lags no more than six months—even in the face of reports that the booster which put Russia's first man in space was of 1.5-2 million lbs. of thrust, which equals or outclasses the 1.5-million-lb.-thrust *Saturn*.

Regardless of how the race stands today, a formidable amount of work lies ahead for the *Saturn* program. Coming up is a full-duration firing of *SA-1*—the first flight version—before the eight-engine booster is taken down from its static test stand here and shipped by barge to Cape Canaveral. The *SA-1* is scheduled to arrive at the Cape in about three months. Launching may be in October.

The *SA-1* stage passed muster in a 30-sec. static firing April 29. The next tests here will include firings of 30 sec. and one for a full 120-sec.-plus. Prior to shipment to the Cape, the rocket will undergo five weeks of mechanical testing of about 10,000 items on 16 subsystems, and another four or five weeks of electronics testing and flight simulation.

• **Critical engine**—The first launching—as well as the next two under present plans of NASA's Marshall Space Flight Center—will have dummy *S-IV* and *S-V* upper stages. The dummy *S-V* is now en route to the Cape along with a prototype booster on a shakedown cruise of the *Saturn* barge Palaemon.

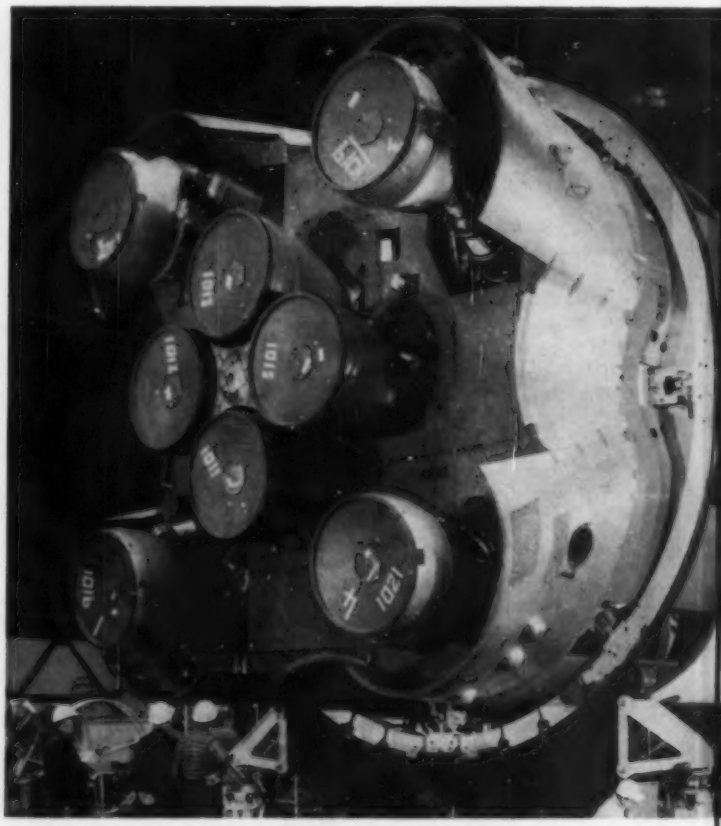
The *Saturn* program is operating on the basis of unlimited overtime in critical areas. NASA Administrator James E. Webb reported last week that the work week of the entire *Saturn* team at Huntsville has averaged between 44 and 48 hours a week since NASA took over technical direction in January, 1960.

Since January, 1960, with the approach of static testing and the first flight test, the average has been 47 hours a week. In the critical areas of fabrication, assembly and testing, the average work week has ranged as high as 54 hours.

Webb said the key factor in the schedule beginning with *SA-4* is the delivery of the hydrogen-oxygen *LR-115* engines (designated *RL-10* by NASA). Pratt & Whitney, the engine contractor, has both shop and test stand employes on a three-shift basis to take maximum advantage of existing facilities at its plant.

• **At $334 million**—Total cost of developing the *Saturn C-1* through its series of 10 R&D flights is expected to be about $1 billion. By June 30, $334 million will have been spent on the project, including $230 million in the current fiscal year. Former President Eisenhower's FY '62 budget called for spending $250 million to carry on the *Saturn C-1* toward a mid-1964 target date for making the vehicle operational.

The first revision of the budget by President Kennedy, submitted to Congress March 28, called for addition of



COMPLETED SATURN BOOSTER 82 ft. tall and 22 ft. in girth is being taken to Quality Division for checkout at NASA-Huntsville Center.

$78 million to begin developing the *Saturn C-2* in a seven-flight program between 1964 and 1966. The biggest single item in the *C-2* development will be a $56-million start on the 800,000-lb.-thrust *S-II* stage.

Most of the staff of Marshall Space Flight Center, of which the nucleus is 80-odd former Germans who developed the *V-2* with Center Director Dr. Wernher von Braun at Peenemunde, is working on *Saturn*. Total employment at Marshall is expected to be 5500 by June 30. A further increase of 450 is provided in Kennedy's March 28 budget revision.

Nevertheless, more than 80% of the money spent on *Saturn* is on contracts with industry—for parts, services, construction and subsystems of increasing size. Only the *S-I* stage is being developed in-house, and even that will be turned over to industry for production after the first 10 R&D vehicles are produced at Huntsville.

In preparation for turning over the whole booster, the Marshall Center is contracting out bigger and bigger components of the vehicle in the latter portion of the R&D program. Chance Vought Corp, recently won a $2 million contract to manufacture 42 tanks of 70 in. diameter for vehicles 6 through 10.

• **Milestones ahead**—Richard B. Canright, chief of *Saturn* class vehicles at NASA headquarters, lists these as the milestones to be accomplished in FY '61:

—Static testing of the protoype *S-I* stage in configuration close to flight configuration at about the expected flight thrust of 1.32 million lbs. and duration of 125 sec.

—Completion of assembly of the first two flight vehicles (*SA-1* in January and *SA-2* in June.)

—Beginning of dynamic tests on the new Dynamic Test Stand. (The stand will not quite be ready for use with *SA-1*. It will be checked out beginning in June with a prototype.

—Static tests of the Pratt & Whitney *RL-10* engine at the specified thrust of 15,000 lbs. and duration of 600 sec.

—Fabrication and checkout of ground support equipment for transportation of the *S-I* stage, qualification of the barge Palaemon and provision for fueling, checkout and launchings from the first *Saturn* launch pad on Complex 34 at Cape Canaveral.

Canright lists these as accomplishments planned for FY '62:

—The first two launchings, *SA-1* in the fall and *SA-2* in the winter or spring.

—Beginning of development of the *S-II* stage, which will increase payload capacity to about 2½ times that of *Saturn C-1*.

—First static firing of the Douglas *S-IV* stage.

—Completion of assembly of *SA-3* and *SA-4*, with the beginning of an increase in the rate of assembly to make ready for the more rapid launching schedules planned for fiscal years 1963 and 1964.

—Full qualification testing of the Rocketdyne *H-1* engine for manned flight and preliminary flight rating test of the P&W *RL-10*.

—Design modification of GSE as a result of experience and requirements for the more advanced, two-pad Complex 37.

After the *SA-1* comes down from the static test stand, the *SAT-1* will go back up for a series of special-problem tests. One of the first will be a test of *Saturn* engine-out operation. At one of the inboard engine positions, the *SAT-1* will have an old test engine that has been used for more than 5000 sec. Its propellant lines will be cut off.

One major hurdle will remain until the bird is flown. No one will be sure until then how it stands up on passage through the sonic region. ¤

ABOUT $1 BILLION will be spent to perfect Saturn C-1 through 10 R&D shots.

UPPER STAGES FOR SATURN C-2 are still being decided. Configurations are for nuclear (left) and 800,000-lb.-thrust chemical second stage.

AT&T, GE File Conflicting Space Communications Ideas

A BATTLE began shaping up last week when two industrial giants filed with the Federal Communications Commission their ideas about the way to set up a commercial space communications system.

The American Telephone and Telegraph Co. proposes that a combine of message-sending carriers and international agencies develop and own the communication satellite facilities.

On the other hand, General Electric Co. doesn't feel that the message-carrying carriers have a vested right to all means of communication. The company recommends that "safeguards should be established to assure that no one communications carrier or aerospace corporation could dominate the firm. . . ."

Both companies want to provide a microwave relay service to all licensed communication carriers for global transmission of telephone, telegraph and communications traffic by means of a space satellite system.

In an apparent answer to GE's newly formed subsidiary, Communications Satellites, Inc., and to similar ventures into commercial satellites by companies unregulated by FCC, AT&T maintains that "ownership participation by others than the carriers providing the communications services would not be necessary or desirable."

Turning a conciliatory glance at GE, AT&T said that "manufacturers and suppliers of satellite equipment and launching facilities will produce the satellites, build the ground stations and supply the rockets, etc." However, AT&T holds that the carrier combine "should have control over the choice of the equipment to be used." ⌗

financial

Lear Inc.—Sales and earnings were the highest in company history. Total sales reached $90.98 million, compared with 1959 sales of $87 million. Operating earnings were $2.8 million, which sales of certain assets raised to $3.6 million. Actual operating earnings were up more than 17% over 1959's total of $2.4 million. Backlog at year end was $78 million, $2 million greater than that at the end of the previous year.

General Telephone and Electronics—Revenues and net sales for the first quarter were $287.7 million, slightly below the corresponding 1960 period. Net income totaled $15.5 million. The manufacturing operations income portion of this amount was less than a year ago, the GTE chairman said. The company announced plans to invest approximately $269 million in new plant and equipment in 1961, and "at least" $2 billion over the next seven or eight years. GTE manufactures communications systems for *Minuteman* and *Polaris* missile-launching subs, MOBIDIC computers and electronic countermeasures systems.

The Martin Co.—Sales rose to $197.9 million for the quarter ending Mar. 31, compared with $140.4 million the same time last year. Earnings were $4.9 million, compared with $3.5 million in the previous year's first quarter.

The Gabriel Co.—Despite a decrease in sales—from $7.7 million the first quarter last year to $6.7 million this year—earnings totaled $140,953 million, compared with $34,734 million.

Chance Vought Corp.—Income for the first three months amounted to $949,270, compared to earnings of $883,162 for the corresponding period in 1960. Sales slipped to $45.5 million, compared with $62.6 million.

North American Aviation—Sales and other income for the six months ending March 31 totaled $573.7 million, compared with $498 million the same period last year. Earnings came up $11.76 million, compared with $11.63 million in last year's six-months period.

American Bosch Arma—Sales for the first three months showed considerable improvement over the same period last year, although income dropped. Income was $612,946 on sales of $34.6 million, compared with income of $664,905 on sales of $32.6 million during the same period in 1960.

Lockheed Aircraft Corp.—First quarter net earnings of $4.4 million, up $1.7 million from a year ago, were reported on sales of $336 million, down $4 million from the same period last year. Backlog amounted to $1.27 billion, up from $1.11 billion a year earlier and $1.22 billion at year-end 1960. Satellites, space research and missiles accounted for $183.7 million of the sales—more than half the company's business.

Republic Aviation Corp.—Sales for the period ending Mar. 31 amounted to $85.7 million. Net income was $2.7 million. This compares with first-quarter sales of almost $35 million and net income of $498,000 for the previous year. The tremendous increase in sales was attributed to increased deliveries of the F-105D fighter-bomber.

General Precision Equipment—Preliminary figures for the first quarter, 1961, showed sales of $62.9 million, up 13% from 1960's first quarter. Backlog at Mar. 31 was $171.8, compared with $181.9 the same time last year. Income for the period was $1.3 million, up from $1.2 million in the first quarter, 1960.

expansions

DOUGLAS AIRCRAFT CO. has opened a $450,000 liquid hydrogen laboratory to test materials and components for use with cryogenic fuels. Facility capabilities include burst-testing at up to 20,000 psi and flow-rate tests of 2000 gallons per minute of LH_2 at pressures up to 125 psi. Compression and stress tests also are being conducted on materials immersed in liquid hydrogen at up to 60,000 lbs. force in either direction. Douglas has a NASA contract to develop the *Saturn S-IV* upper stage.

VITRO CORP. and Selenia S.p.A., a Raytheon Co. subsidiary, have formed a new company in Italy for the design and installation of missile systems and other electronic equipment. The new company, headquartered in Rome, will be known as Vitroselenia.

ATLANTIC RESEARCH CORP.'s new experimental radiation laboratory is going into operation this month at the company's Alexandria, Va., headquarters. The $150,000 lab will be used for experiments with waste products from atomic reactors, radiation damage studies, and investigation of solid-propellant combustion using isotopes as tracers.

IMM INDUSTRIES INC. has been formed by Lewis W. Imm, past president and founder of Librascope. Imm Industries will concentrate on logistics and control of weapon systems, military information processing, navigation and control of air and space vehicles, and commercial projects. The new company is located in North Hollywood, Calif.

(Continued on page 46)

The blueprint . . .

How DOD Will Revise Its Budgeting

***THE DEFENSE DEPARTMENT** is moving toward an extensive revision of its budgeting and planning processes.*

The master blueprint for this revision is a paper written by Defense Comptroller Charles J. Hitch. He began circulating it in official Pentagon circles about the middle of last month.

The paper clearly reflects many of the ideas expressed by Hitch in his recent book, "The Economics of Defense in the Nuclear Age."

Hitch circulated the paper as a proposal. However, except for adjustments that may be found necessary, it is expected to form the outline for Pentagon budgeting procedure during the Kennedy Administration.

Because of the paper's obvious importance, M/R is publishing it in full.

by Charles J. Hitch

THE FUNDAMENTAL objective of the new Programming Office in the Comptroller's Office is to integrate the planning and programming and the financial management functions in order to provide better tools for decision-making by the Secretary of Defense and his military advisors; and to create a planning and programming/financial management system that is keyed to continuous program decision-making and not just geared to the annual budget cycle.

In such a system, not only would budget decisions be program decisions, as they inevitably are now, but program decisions would be budget decisions. That is, decisions to embark on programs would be explicitly decisions to provide the resources required to carry them out.

One important effect of such a system would be to reduce the wastes that have resulted from the fact that our plans and programs for future years have so often over-reached our resources and budget availabilities, with consequent necessity, in budget review after budget review, of killing, curtailing or stretching out uneconomically, programs on which vast amounts have already been spent.

We need an economically realistic future program so that long lead decisions on program components will have a reasonable chance of turning out to be right. To develop such a program, it is essential that the decision makers have before them the total cost implications of alternative programs—not only total in the sense of cutting across appropriation categories, but also in the sense of being projected over the life of the program, or at least projected forward over a 5-year period.

• **Time needed**—Another important effect of such a system would be to allow us to get away from the arbitrary imposition of financial ceilings early in the budgetary process before major program decisions have been made, and therefore, independently of such decisions.

Our ultimate goal cannot be achieved within a few months. However, we do want to go as far as we can in this direction in the decision-making process for the FY 1963 budget. The procedure we want to follow in the development of the FY 1963 budget, and its relationship to the longer run objective, in outline, is as follows:

The traditional budgetary process will be divided this year into a programming phase (June to September) and a budgetary phase (October and November). During the programming phase the Secretary, with his military advisors and his staff, will examine a broad range of alternative programs and make decisions that will form the basis for guidance on the preparation of the budget. During the programming phase, attention will be focused on choice from among alternative programs to achieve our national security objectives. For this purpose, cost and effectiveness comparisons will be made using largely statistical cost factors rather than the detailed information that must be submitted in support of the budget submission.

The subsequent budgetary phase will concentrate on funding requirements to carry out the programming decisions. Because the programming phase is the major innovation, I will explain it in some detail.

First, general policy guidance will be provided by the revised Basic National Security Policy paper which is now in preparation and which will be reviewed by the Secretary and his principal advisors in May.

Second, we would require that as many programs as possible, certainly all of the major consumers of dollars and other resources, be identified on a mission or output oriented "program package" and "program element" basis.

• **Two key units**—By a "program element," we mean an integrated activity, a combination of men, equipment, and installations, whose effectiveness can be related to our national security policy objectives; as examples, we have in mind such forces as B-52 wings, infantry battalions, and combatant ships, taken together with all the equipment, men, installations, supplies, and support required to make them effective military forces.

By a "program package" we mean an interrelated group of program elements that must be considered together because they support each other or are close substitutes for each other. The Central War Defensive forces would be an example of such a package. The unifying principle of such packages is a common mission or set of purposes.

Total resource requirements for each of these program packages or elements would have to be identified, not only for FY 1963, but for 5 to 10 years into the future, depending upon the present phase and life of the program, and including not only RDT&E, procurement and installation costs, but also the costs of military personnel and operation and maintenance, and, where applicable, warhead costs.

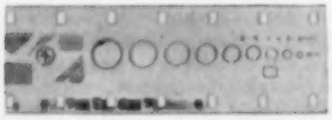
The Office of Programming has already undertaken the job of identification of program packages. We have a provisional list ready now. The degree of detail presented in it will have to be refined as the work progresses. In some cases it is inadequate while in other cases it may be excessive, or simply not broken down in quite the right way.

To continue the work of refinement, a program package team is being formed to consist of members of the Office of Programming, representatives from each military department, the JCS, the Office of Deputy Assistant Secretary (Budget), and Assistant Secretary of Defense (ISA). We will also take advantage of assistance from contractors who have studied and are knowledgeable in this sort of activity.

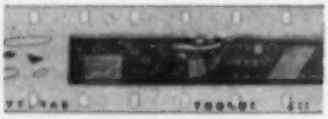
The tasks of the program package team will be several—first will be definition of specific contents of packages that have meaning from a planning and programming/financial management point of view. Second, the resource elements of the packages will be identified on as consistent a basis as possible.

NARROW-CHANNEL PHOTOGRAPHY

For people with the problem of photographing the interior of long, narrow channels, Kollmorgen has developed unusual devices capable of recording on film channels as narrow as ½ of an inch.

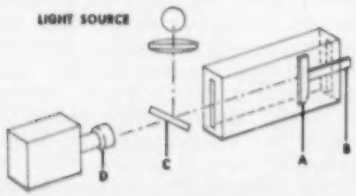


Above, actual size, is a test film of circles and numerals placed within a ½"-wide channel.



Above is a *panoramic* view of a continuous section of the same film . . . with marks enlarged 8x.

Pitting, corrosion, fracture and other defects of interior walls can be continuously recorded with full-dimensional accuracy . . . of exceptional value in quality control operations.



The secret of our insight: A highly precise 45° mirror (A), mounted on a reed (B), is inserted in one end of the channel. A beam splitter (C) directs a powerful light into the channel from the opposite end which is reflected by the mirror onto the sidewall. The photographic leg of the system receives the image from the channel mirror and through the beam splitter. A camera objective (D) focuses the image on the film. The channel is advanced by a carriage in precise synchronization with the advance of film. Result: a continuous, clear photographic record of the entire channel.

Various modifications of this device have been applied to channels up to six feet long. For longer and wider channels we have designed a miniature self-propelled camera, mirror and light source capable of presenting a continuous image on film with resolution sufficient to reveal scratches and hair-line cracks smaller than .010 inch.

If you need special insight on "inaccessible" interiors, or information on other unusual applications of optics/electronics/mechanics—let's talk it over.

Write Dept. 6-5

KOLLMORGEN CORPORATION
NORTHAMPTON, MASSACHUSETTS

Third, formats for clear and concise submittal purposes will be established, as well as formats and procedures for tentative approval of program packages by the Secretary of Defense and for updating approved packages. The ground rules regarding specification of military units, locations, activity rates, etc., will also be decided upon, and finally schedules for submittals by the military departments will be established.

The definition of a program element or package will involve both financial and non-financial factors; that is, a specification of both cost and capability. Costs will be expressed both in terms of expenditures and obligational authority. There is no thought at this time of abandoning the existing appropriation categories. Rather, our intention is to supplement them with program and cost information that is more meaningful for decision-making purposes.

• **Many questions**—We wish to define the program packages by the 1st of May, realizing of course that these will be preliminary definitions to be improved upon as we progress. The Programming Office will monitor the process of refinement of the package definitions.

Third, guidance will be provided on questions to be answered and studies and analyses to be performed in connection with the program review. Broadly speaking, we visualize four classes of questions, each to be answered by appropriate supporting analyses.

(1) First, there are questions regarding the forces themselves together with their associated weapons, equipment and installations. Do we want more, less, or the same amount of each type?

We must examine each force element in terms of both cost and effectiveness: costs in the sense of complete program costs, and effectiveness in the sense of military effectiveness in support of our Basic National Security Policy objectives. We must examine the costs and effectiveness of continuing existing forces unchanged, adding to them, or phasing them out.

These examinations must be made in the realization that more forces are always useful, but that the real questions are how useful, how important, and how effective, in comparison with alternative ways of achieving the same Basic National Security objectives within the total amount of resources available.

(2) Second, there are capital expenditure decisions to be made in connection with these forces. We want to look at each major item of equipment in relation to the force it is to equip, and to see how much is required for peacetime operation, and how much must be stockpiled for wartime readiness. We need to know all the costs and the implications of effectiveness of continuing to use existing equipment, modernizing, converting or rehabilitating it, or replacing it.

For example, in connection with each proposal for new ship construction, we need to consider the alternatives of:

(a) Continued operation of the existing ship;

(b) Modernizing or converting it;

(c) Replacing it with a new one or new ones of the same or different types; or,

(d) Phasing it out, along with its personnel and support, without replacement.

(3) Third, there are questions relating to activity rates and deployments. What activity and deployment factors affect the cost and effectiveness of the force? How do cost and effectiveness vary with, e.g., flying hours, maintenance schedules, exercises, alert status, crew ratios or manning levels, etc.? Which if any should be changed? Why? Can costs be reduced without commensurate reduction in effectiveness by variation in activity levels?

(4) Fourth, there are questions about management. Are our major forces organized efficiently? Do the supporting forces and activities bear an appropriate relationship to the combatant forces? Are the tables of organization right? Are the bases and installations in balance with the forces they support? Is the logistic guidance appropriate to our objectives?

• **Ike budget a benchmark**—Then there are special questions relating to research and development decisions. Here we want to examine each major weapon system program, as well as the basic and applied research program. In the case of weapon system developments, we want to know how effectively the system could contribute to which military objectives, the total development cost (in whatever appropriation account), and the future capital and operating costs if a decision were made to procure it.

In addition to general guidance on the supporting studies and analyses, there will be a more detailed list of questions and requirement studies associated with each program package review. This list will supplement the Secretary's list of 121 projects and include many items on it.

As program decisions are made, we will need some sort of benchmark to tell us where the decisions are leading us in terms of a total budget. We plan to use two controls. The first is the 1962 budget. For the second, we intend to ask the Services to cost out, in expenditures and NOA terms, the force structure submitted by the JCS in answer to Mr. McNamara's Project No. 3, that

(Continued on page 39)

Technical Countdown

ADVANCED MATERIALS

Beryllium Prices Drop Again

Virgin powder prices have been cut 12% by Brush Beryllium Co. A 15% slash in 20,000-lb. base-lot blended powder prices was announced by the firm because of the increased production capabilities at its Elmore, Ohio, plant. The facility will ultimately up Brush's output of pure beryllium to more than 30,000 lbs. a month.

Magnetic Resonance Provides Testing Tool

Nuclear magnetic resonance may be a critical tool in future non-destructive testing methods. Interpretation of Atomic-scale resonance measurements can supply information on lattice strain effects and solute concentration. Union Carbide physicists caution that extensive background in the field is a prime requirement, but they say the technique can be reduced to routine testing if properly developed.

TFE-Fluorocarbon Resins Standards

A standard establishing requirements and methods of test for three grades of TFE sheet in material, dimensions, physical and electrical properties has been submitted to industry by the Business and Defense Administration of the U.S. Commerce Dept. The standard, covering minimum thickness of 1/32 in., is the result of a request from the Society of the Plastics Industry.

SUPPORT EQUIPMENT

Space Surveillance Training Accelerated

The Air Force has stepped up its training program for operators of space surveillance facilities. A total of 28 officers and men are now taking an accelerated course at Hanscom Field to qualify them to operate SPADATS (space detection and tracking system) for NORAD. In addition to classwork in astronomy and satellites, the students are checked out by on-the-job training in satellite tracking at the AF Space Track facility.

Plasma Tunnel Being Completed

A plasma wind tunnel capable of sustained operation at speeds of Mach 3 and higher is scheduled for completion this month. The $350,000 tunnel, being built by North American Aviation, will be used for testing manned vehicles under re-entry conditions. The hypersonic gas flow is generated by a one-megawatt d-c arc which heats the plasma to temperatures in excess of 16,000°F.

PROPULSION

R-F Plasma Engine for Space

A plasma-propulsion space engine which uses UHF radio waves to accelerate charged particles has been demonstrated by RCA scientists. The device uses r-f power rather than magnets to produce the accelerating electrical field. Thrust can be increased by using higher frequencies to accelerate a denser plasma.

ELECTRONICS

Transistor Sales Up

February transistor sales gained one million units over the previous month, EIA reports. Sales for the first two months of 1961 were up a total of over 6 million units over the same period last year. Dollar volume was down almost $1 million, however, reflecting steadily decreasing unit costs.

Micromodule Development in Second Phase

P. R. Mallory, Indianapolis, Ind. and Paktron, Alexandria, Va., have been selected by the Army Signal Corps to develop alternative methods for assembling micromodule circuits on a production basis. Phase One of the program, carried out by RCA and some 50 other manufacturers over the past three years, established the feasibility of the micromodule concept.

Missile Fabrication Patent Awarded

Convair/Pomona has just received a patent for its technique of manufacturing missiles by means of wheel-shaped subassemblies. The patent covers a design employing circular cross-sectional slabs of electronic circuitry. These are joined longitudinally by four tension bolts extending through all of the sections to be assembled. The concept reportedly reduces the size and weight of missile structures by a ratio of 6:1.

ENERGY CONVERSION

Another Bacterial Fuel Cell Announced

Generation of electricity by the chemical reaction of living organisms (bacteria) has been successfully demonstrated by a second researcher. Joseph Kaye & Co., Cambridge, Mass., developers of the new "bug battery," say that chemical reaction rates obtained with bacteria are as much as a million times faster than those of conventional chemical reactions. Fuels for such a cell are common and practically unlimited—sewage is one example. Announcement of the success came soon after disclosure (M/R, April 17, p. 18) of a similar development by Dr. Frederick D. Sisler of the Interior Department.

Lampre I Begins Operation

The world's first molten-plutonium experimental nuclear reactor, *Lampre I*, has achieved a self-sustained controlled chain reaction at operating temperature at Los Alamos Scientific Laboratory. *Lampre I* will help evaluate the idea of using metallic plutonium as a fuel in liquid form. Low melting points may thus be changed from a disadvantage to an advantage.

OPTICS

Fiber Optics to be Lasered

First application of fiber optics to lasery may be made by American Optical Company's research center in Southbridge, Mass. Its scientists have several projects under way for the employment of very-fine-diameter clad fibers in the laser geometry. AO believes these will permit highly precise mode selection and mode coupling and thus significantly lower power requirements. (See report on page 33.)

Exclusive: Titan Gets Ablative Skirt

by Frank G. McGuire

AZUSA, CALIF.—An ablative skirt adopted for the second-stage engine of both *Titan* versions will allow a "dry start" ignition expected to greatly increase reliability.

Aerojet-General Corp., developer and producer of all *Titan* engines, says the new skirt will make it possible to ignite the engine without the presence of fuel in the regeneration-cooling tubes of the chamber wall, and the possibility of leakage causing an explosion.

Fuel and oxidizer will be sealed off behind flow control valves until ignition has been achieved in the combustion chamber, at which time the fuel will be introduced to regeneratively cool the chamber.

In *Titan II*, the ablative skirt takes up almost all the expansion chamber, from 13:1 to the full 45:1 ratio areas.

Fabrication of the chamber skirt is begun by shingle-wrapping a pre-impregnated asbestos tape at a 45° angle to the surface of a rotating mandrel. The tape, containing the phenolic resin, is then covered with hair felt and glass contour tape so that volitiles generated during curing may escape.

A vacuum bag is placed over the entire assembly to maintain a vacuum or 22 to 30 in. Hg during the curing operation up to temperatures of 330°F. During this cure, the vacuum-bag-wrapped mandrel is in an autoclave maintained at 185 to 250 psig.

After cure, the liner is machined to proper dimensions while still on the mandrel; then reinforcement in the form of glass cloth is applied to the outside surface. The glass cloth, like the original asbestos tape, is pre-impregnated with phenolic resin

● **Bonding and reinforcing**—At this point, the attachment flange for mating with the combustion chamber is applied, using aluminum alloy 6061-T6. The segments of this flange are bonded to the forward edge of the liner with a liquid adhesive.

This bond is reinforced with asbestos-reinforced phenolic tape and phenolic-resin-impregnated glass cloth applied over the flange segments and the entire length of the skirt liner. Curing is then conducted for one hour at 320°F.

Another reinforcing factor is then laid on by application of a cellular fibreglass core, held in place by a film of adhesive. Pre-cut sections of fiberglass core are put in place, the entire skirt being again cured at 300°F for one hour, after which the core is trimmed and shaped.

An epoxy filleting compound, cured by heat lamps, is applied to the aft edge of the skirt to act as reinforcing. This compound is wrapped with glass tooling tape.

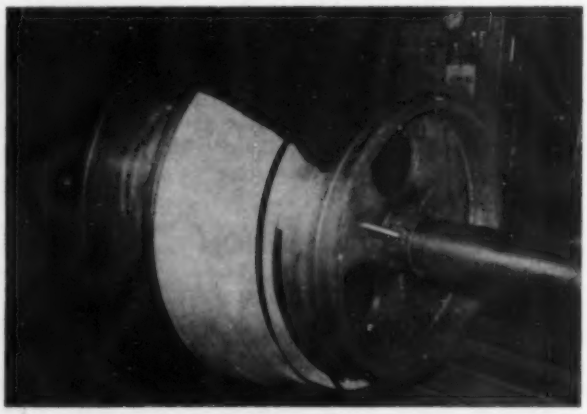
Final outer wall of the skirt is formed of phenolic-resin-impregnated glass cloth cemented to the cellular core in segments. Epoxy-resin-impregnated glass roving is wrapped over the flange area.

Final curing is for two hours at temperatures between 220° to 280°F.

Approximately 14% by weight of the asbestos is water, released between 1200° and 1400°F. At about 1490°F, the asbestos changes phase, and subsequently melts at around 2800°F. ■

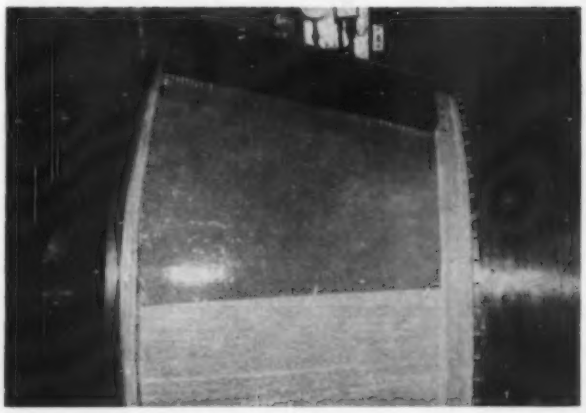
1 *Mandrel of 6061-T6 aluminum with surface finish of 65 to 125 RMS used for wrapping ablative liner for Titan skirt.*

2 *Shingle wrapping of asbestos tape, pre-impregnated with phenolic resin, on the aluminum mandrel.*

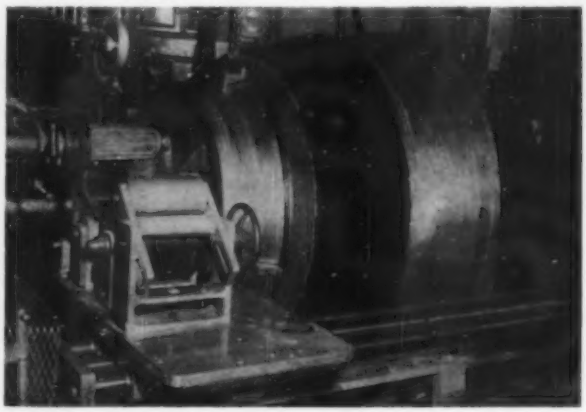


3 *Glass contour tape and hair felt, to permit escape of volatiles during cure, are applied over asbestos lay up.*

irton 2nd Stage



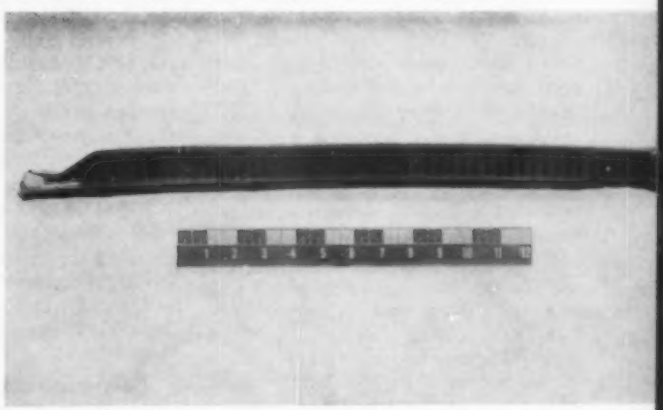
4 *After even cure, liner is machined, supported film adhesive applied to liner, fiberglas applied to adhesive.*



5 *Cellular fiberglas segments shown in place on skirt and ready for curing.*

6 *After cure, the cellular fiberglas reinforcement is machined to proper dimensions.*

7 *Completed ablative skirt for Titan's second-stage engine. Earlier models had chambers of hollow steel tubes.*



8 *Cross-section of the ablative skirt after a full-duration firing. Note char depth of the ablative liner.*

IBM Dedicates Giant Research Center

Watson facility, believed to be world's largest for data processing R&D, to be used as 'international clearing house'

NEW CRESCENT-SHAPED Thomas J. Watson Research Center was formally dedicated last week. The world's largest facility for computer research, its expandable structure now provides nearly 3 million sq. ft. of floor space for 1500 International Business Machine Corp. personnel.

YORKTOWN HEIGHTS, N.Y.—International Business Machines Corp. has opened what is believed to be the world's biggest research complex devoted to advancing data processing technology.

The vast Thomas J. Watson Research Center, dedicated here last week, is also a striking demonstration of the growing emphasis on R&D and the trend toward manpower consolidation by major manufacturers. Some 700 top scientists, engineers and technicians—plus a 300-member support staff—have been assembled from many of IBM's laboratories around the world.

A press review served as a rehearsal for the formal opening of the Center at the corporation's annual stockholders' meeting last Tuesday. (A circus tent was erected at the rear of the Center to accommodate 3000 stockholders.)

The three-story, five-block-long building is the epitome of modern functional architecture. Throughout, it is designed for maximum well-being of its occupants; even its location, in quiet, rolling upper Westchester County, is inducive to relaxed concentration.

In the Center's work, it is expected that all of the classical scientific disciplines will be represented. An IBM spokesman indicated that about 25% of the studies performed will be in pure research. The applied research and development effort will, of course, be directed to the general field of information processing.

But, it was stressed, the Center will employ a freer approach to R&D than that found in IBM's separate operating-division laboratories.

Central areas of interest at the Center, said IBM, will be solid-state physics, chemistry, and mathematics. Because of current trends in computer technology, the disciplines of biophysics, information retrieval, and linguistics will be heavily stressed.

IBM will use the facility as an "international clearing house for new thinking in computer science." Other principal research laboratories for IBM will remain at Columbia University in New York, San Jose, Calif., and Zurich, Switzerland.

• **Organization**—Six broad exploratory fields or divisions comprise the organization of the new facility:

—General Science for the present will stress studies in lasers, magnetics, cryogenics, and semiconductor phenomena—particularly ferrites.

—Solid State Science will probe for new materials and for new processes and controls for obtaining such materials in useful form. Much of its work will be in the study of low-temperature, thin-film deposition instead of the more conventional high-temperature cracking processes used widely in industry.

—Experimental Systems are concentrating on the machine translation of languages, and on new systems for information retrieval for control of industrial processes.

—Experimental Machines will deal primarily with advanced concepts for super-speed computers.

—Engineering Science is concerned with studying pattern-recognition (aural and graphic) systems. Much of the work has centered on the study of acoustics and vowel recognition by tape editors. Such work may someday permit verbal commands to automatic industrial control systems or even automatic printout of human dictation, said one of its scientists.

—Mathematical Sciences will investigate new logical approaches to computer design. It will also study the whole gamut of computing and operating problems.

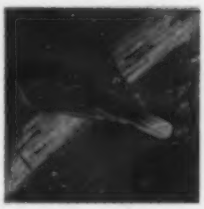
• **Painstaking design**—The structure, designed by Finnish-borne Eero Saarinen, embodies an unusual architectural form for such a facility. The building is crescent-shaped and almost completely enveloped in glass.

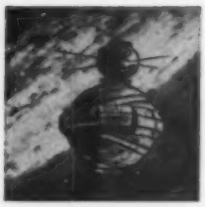
Primary interior and exterior walls are finished with rugged field stone.

All laboratories and offices are windowless, opening into short radial aisles. This approach was the result of a long study of scientist and engineer work habits by Saarinen. Office appointments and colors were selected according to the majority preference of the users.

Total floorspace for the structure is almost 3 million square feet. Most nonstructural walls within the building are movable, permitting great flexibility in changing floor space arrangement.

The curved structure eventually will accommodate some 1500 occupants and can be expanded readily at any time. ⌗





MAY, 1961

MISSILES and ROCKETS

ASTROLOG

Current status of U. S. missile and space programs plus all orbiting satellites

Satellites and Spacecraft

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**ADVENT** (Army)	Army Signal Corps, prime; Bendix prime for 24-hour satellite communications package; GE, vehicle	Twenty-four hour instantaneous repeater communications satellite; 1000 lbs.; program incorporates Projects STEER, DECREE and COURIER	R&D; ground sites to be equipped at Ft. Dix, N.J., and Camp Roberts, Calif.; shipboard terminals also being designed; first ATLAS-CENTAUR launchings late '62
ANNA (Army, Navy, AF, NASA)	No contractors announced	Geodetic satellite; 50-100 lbs.; probably spherical	Study completed; R&D program appears imminent
★**AEROS** (NASA)	No contract announced	24-hour weather satellite to be boosted by CENTAUR	Planning. First flights would be in 1964 or 1965; unfunded FY '62 budget; TV camera R&D to begin soon
★**APOLLO** (NASA)	Convair, Martin, GE	Three-man spacecraft capable of orbiting moon or becoming space station; probably winged for lunar flights; boosted by SATURN	Six-month studies due in May; first orbital station tentatively scheduled about 1967; R&D contract possibly to be let in FY '62; plans delayed
ARENTS (ARPA)	Convair, prime	Satellites to investigate deep space; 22,000 m. orbits; ATLAS-CENTAUR booster	Contract let to build three payloads; launchings begin early '62
ASP (Air Force)	No contracts announced	Aerospace plane, a manned spacecraft capable of operating in the atmosphere and space	Study
★**BAMBI** (ARPA)	Convair, STL	Satellite system capable of intercepting enemy missiles in boost phase	Studies
CSAR (Air Force)	No contracts announced	Communications satellite system; satellites to weigh possibly two tons; to use passive lens reflectors	Studies; possibly operational mid-60's
★**DISCOVERER** (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings of early stabilized satellites; main purpose is to test techniques for military space systems	Launchings: 23; 5 capsules recovered from orbit (3 air-snatched); after orbiting earth one to three days; plans to put simians in capsules delayed.
★**DYNA-SOAR I** (Air Force)	Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell, guidance; RCA, communications data link	Boost-glide orbital spacecraft; R&D leading to first space bomber; TITAN II booster; 3rd powered stage to be added	R&D; first glider flights from Edwards AFB by 1962; R&D space flight about 1966; program accelerated somewhat under FY '62 budget
★**ECHO** (NASA)	Langley Research Center, prime	ECHO I: 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite; ECHO II: 135-ft., 700-mi. orbit	In orbit since Aug. 12, 1960; ECHO II scheduled to be launched 1962; suborbital tests late '61

★ Indicates change since March 1961 Astrolog

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
MARINER (NASA)	JPL, prime	600-1200 lb. unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B	Seven shots planned. First scheduled Venus fly-by Aug. 1962
★**MERCURY** (NASA)	McDonnell, capsule	First U.S. manned satellite; 2500 lb. capsule; ATLAS boosted	First manned orbit shot expected late 1961 or early 1962. Attempt to orbit unmanned capsule April 25 failed because of booster malfunction
★**MIDAS** (Air Force)	Lockheed, prime; Aerojet, IR detector system	Early-warning satellite; detect ICBM launchings by infrared before birds leave pad; R&D models weigh 2.5 tons; operational system to have 12-15 satellites	R&D; second launching May 24 partial success; components being tested by DISCOVERER
★**NIMBUS** (NASA)	GE, prime	2nd generation weather satellite; 650 lbs.; 6 TV cameras in payload; THOR-AGENA B booster	First launching scheduled for late 1962
★**OAO** (NASA)	Grumman, prime; Westinghouse, electronic components; GE, stabilization and control	3500-lb. orbiting astronomical satellite observatory equipped with telescope; boosted by ATLAS-AGENA B	First flight scheduled in late 1963 or 1964
OGO (NASA)	Space Technology Laboratories, prime	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters	First flight scheduled in 1963
OSO (NASA)	Ball Brothers, prime	350-lb. orbiting solar observatory; THOR-DELTA booster	First flight planned summer 1961
PROSPECTOR (NASA)	No contract announced	Soft-landed, remote control, unmanned moon exploring spacecraft; SATURN booster	First flight planned by 1965; study contracts to be awarded in 1961
RANGER (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket	300-lb. instrumented capsule rough landed on moon; ATLAS-AGENA B booster	R&D; first flight planned 1961; first lunar landing planned for 1962, instrumentation to include seismometer.
★**REBOUND** (NASA)	No contract announced	System of 3 to 6 multi-launched ECHO II communications satellites	First orbital flight scheduled for 1963 or 1964
★**RELAY** (NASA)	No contracts announced	85-lb. active repeater communications satellites. Commercial system planned; DELTA and AGENA B launched	Contract to be awarded soon
SAINT (Air Force)	RCA, prime	Anti-satellite satellite inspection system; to be complemented by interception system; about 2 tons; ATLAS launched	R&D underway; to be launched against reflectors or balloons in 400-mi. orbits late '61
SAMOS (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs.	R&D; SAMOS II successfully launched Jan. 31 from Vandenberg. First launch failed to put SAMOS in orbit Oct. 11; scheduled to be operational late 1962, early 1963 under new, bigger program; components being tested in DISCOVERERS
SLOMAR (Air Force)	Lockheed and Martin, prime	Logistics, maintenance, supply spacecraft for space systems	Study contracts awarded in December
★**SURVEYOR** (NASA)	Hughes, prime	750-lb. spacecraft soft-landing 100-300 lbs. instruments on moon; ATLAS-CENTAUR booster	First moon flights 1963; seven to be launched by 1965
TIROS (NASA-AF-Army-Navy-Wea. Bu.)	RCA-Army Signal Corps, prime	Meteorological satellite; TV pictures of cloud cover; TIROS II carried IR scanner	R&D; first launching last April; second Nov. 23, both successful. At least one more planned
★**TRANSIT** (Navy)	Applied Physics Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50-100 lbs.	TRANSIT IB R&D satellite in orbit April 13; IIA plus piggyback satellite in orbit June 22; TRANSIT IIIB launched into poor orbit Feb. 21; four-satellite system scheduled to be in orbit 1962
VOYAGER (NASA)	No contract announced	Unmanned spacecraft to orbit Mars or Venus; eject capsule for re-entry; SATURN booster	Study; first flight planned by 1965
YO YO (Navy)	No contract announced	Tactical sea-launched one-pass reconnaissance satelloid	R&D
★**X-15** (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; 4000 mph; flight at edge of space; an AF model each XLR-11 rocket engine develops 16,000 lbs. of thrust; XLR-99 engines 50,000 lbs. Three planes delivered.	Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-11 engine; plane #2 with XLR-99 engine turned over to NASA; has hit 3074 mph speed record; altitude record of 169,600 ft. (unofficial for manned, powered flight)

Missiles and Rockets

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ALFA (Navy)	Navy, prime; Avco, air frame	ASW surface-to-underwater; 500 lb. solid; conventional	Deployed on destroyer escorts
ARM (Air Force)	No contract announced	Anti-radar missile; air to surface	Studies; plan for separate missile shelved at least temporarily
ASROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, sonar; torpedo, GE; depth charge, M-H	Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional, range about 8 miles; advanced ASROC (improved Mark 44 torpedo) under R&D	R&D; operational on Destroyers Norfolk, Adams, Dewey and Perry; plans call for deploying on 150 destroyers and cruisers
ASTOR (Navy)	Westinghouse, prime	ASW underwater to underwater rocket torpedo; nuclear	R&D
★**ATLAS** (Air Force)	Convair; prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle	ICBM; more than 5500-to-7500 mile range; liquid; nuclear; ATLAS "E" series has inertial guidance; earlier ATLAS "D" has radio inertial; proposed ATLAS "G" would have 900,000-lb. thrust and 4000-lb. payload capability	82 launchings; 53 successes, 20 partial, 9 failures; 11 bases for 13 squadrons; operational at Vandenberg and Warren; ATLAS E tests began Oct. 11; about 18 to 21 launchers operational—40 to 60 expected in 1961. First successful "E" shot Feb. 24
★**BOMARC-A** (Air Force)	Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 250 m. range; Mach 2.7; nuclear	Five bases operational in Northeastern U.S. from Virginia to Maine
★**BOMARC-B** (Air Force)	Boeing, prime; Kearfott/Westinghouse, IBM Guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 m. range; nuclear	8 models being produced; a B test bird intercepted simulated target 345 miles away Oct. 14; to be deployed at 6 U.S. bases, two in Canada
★**BULLPUP** (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol, Naval Propellant Plant, propulsion; Maxson, second-source prime	Air-to-surface; 3-6 mile range; conventional 250-1000-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model nearly operational; AF designation: GAM 83-A (HE warhead), GAM 83-B (nuclear)	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; soon operational with Air Force units. Marines launching BULLPUP from helicopters
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
COBRA (Marines)	Boelkow Entwicklungen, West Germany, prime manufacturer; Daystrom, U.S. licensee	20.2-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant	Marines planning to purchase; Army considering them; already operational with West German troops
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested
DAVY CROCKETT (Army)	In-house project directed by Rock Island, Ill., arsenal	Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men	R&D; operational this year; first NATO deliveries also this year
★**EAGLE** (Navy)	Bendix, prime; Bendix, guidance; Aerojet, propulsion; Grumman, airframe	Air-to-air; 100-mile range; nuclear; for launching from relatively-slow Douglas Missileers now under development; EAGLE is 15 ft. long; wt., about 2000 lbs.; Mach 4; solid	Program cancelled
★**ENTAC** (Army)	Nord Aviation, prime	Anti-tank; 6600-ft. range; 37 lbs.; HE warhead; wire-guided	Operational; Army buying from French in quantity
FARMIDS (Army)	Convair, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies	Mobile anti-missile defense system	Each of six contractors have $250,000 feasibility study contracts awarded Oct. 10; reports expected mid-'61
★**FALCON** (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion.	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 has nuclear warhead	GAR-1 through GAR-4 operational; GAR-9 R&D; GAR-11 operational in near future; buy-out of GAR 3A, 4A and 11 in FY '62
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D

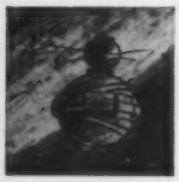
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 22-mile range; solid; conventional; designed to hit low-flying planes	Operational; deployed at Panama, Okinawa; SUPER HAWK under development; Jan. 29, 1960 successfully intercepted HONEST JOHN, first known missile intercept of another
HONEST JOHN (Army	Douglas/Emerson Electric, prime; Hercules, propulsion	Surface-to-surface; unguided; 12-mile range; nuclear	Operational; deployed in Europe
HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400
★**JOSHUA** (Air Force)	No primes announced	Lightweight ICBM nuclear	Study; some hardware
JUPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle	IRBM; liquid; nuclear; can be made mobile	To be deployed with Italian and Turkish troops. 31 military launchings: 24 successes; 5 partials; 2 failures. Full tactical GSE used for first time in Oct. 20 shot from Cape
LACROSSE (Army)	Martin, prime; Martin, guidance; Thiokol, propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; three units deployed in Europe; more being trained; advanced LACROSSE R&D dropped
LAW (Army)	Hesse-Eastern Div., Flightex Fabrics, prime	Light anti-tank rocket; carrier tube launcher; 4.5 lbs.; 25 in. long/3 in. diameter	R&D under AOMC
LITTLE JOHN (Army)	Emerson Electric, prime; Hercules Powder, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	First 4-launcher battalion operational this winter
LOBBER (Army)	No contract announced	Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm; LOBBER with warhead called BALLISTA	Studies
LULU (Navy)	General Mills/Naval Ordnance Lab, prime	Small nuclear depth charge air-dropped or launched by ASROC	Operational
MACE (Air Force)	Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has more than 1200 n. range	Being deployed with U.S. troops in West Germany; now all mobile but hard-base version in R&D; to be in Okinawa, Korea
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650-mile range	Being turned over to West Germans; also deployed in Far East
MAULER (Army)	Convair, prime	Surface-to-air; radar guidance; highly mobile antiaircraft and antimissile missile for field use; on tracked vehicle; 12 missiles per launcher	R&D; NATO may buy
★**MINUTEMAN** (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle; AMF-ACF, rail launcher	2nd generation ICBM; solid; fixed or mobile aboard railroad trains; nuclear; 3 stages	R&D; scheduled to be operational mid-1962 at Malmstrom AFB; first R&D flight (all stages igniting) from Cape Feb. 1 a success; tactical rail system tests completed; 3 squadrons at Malstrom; 3 at Ellsworth AFB, S.D.; 12 fixed squadrons now planned; mobile system indefinitely postponed
M-55 (Army)	Norris Thermador, prime	Four-inch diameter, small, short-range poison gas rockets; to be fired from 45-tube launchers	Operational
MISSILE A (Army)	ARGMA, prime	Surface-to-surface; 10-20 mile range; solid	Design studies
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Thiokol, propulsion; Douglas, airframe	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East; about 170 batteries in U.S., sixty-eight more to be phased out and replaced with NIKE-HERCULES
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion; Douglas, airframe	Surface-to-air; 75-mile range; Mach 3+; nuclear; anti-aircraft, tactical missiles; mobile or fixed	Rapidly replacing NIKE-AJAX; well over 80 batteries deployed in U.S.; more than 10 N-H batteries being deployed overseas in 1961; N-H on Formosa
★**NIKE-ZEUS** (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol/Grand Central, propulsion; Douglas, airframe	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands, 14 R&D launchings; 8 successful, 4 partial, 2 failures. Complete system tests now scheduled for early '62
★**PERSHING** (Army)	Martin, prime; Bendix, guidance, Thiokol, propulsion	Surface-to-surface; two-stage solid; approx. 500-mile range; nuclear; transported on FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range	R&D; to replace REDSTONE; 15 R&D launchings; 13 successes (both stages launched, guidance carried as passenger Dec. 12 for first time), 2 failures. Operational late 1961; R&D launching about 250 miles April 21

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**POLARIS** (Navy)	Lockheed, prime; GE/MIT, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear; POLARIS II (1500-mile range) and SUPER POLARIS (2500 mile range) under R&D	94 launchings of test vehicles; 62 successes; 21 partial; 5 failures; 20 also launched from submerged subs—all cleared surface; 12 successful flights, 8 failures. Two subs each with 16 missiles operational, 3rd deploying this spring. Total authorized by White House: 29. POLARISES for cruiser Long Beach cancelled; Polaris II R&D missiles impacting 1400+ n.mi. in guided flight
QUAIL (Air Force)	McDonnell, prime; Summers Gyro, guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment	ECM-carrying bomber decoy; about 200 m. range; jet powered	Deployed at SAC bases; carried by B-52
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
REDEYE (Army)	Convair, prime; Philco/Convair Atlantic Research, propulsion	Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable	R&D; Marines also will use; NATO may buy
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe; to be replaced by PERSHING
REGULUS I (Navy)	Chance Vought, prime and guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines; REGULUS II used as target drone
SEMPER (Marines)	No contracts announced	Believed to be an air-launched missile	R&D testing at Pt. Mugu
SERGEANT (Army)	Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear	In production
SHILLELAGH (Army)	Aeronutronic, prime	Surface-to-surface; lightweight; can be vehicle-mounted	Early R&D
SIDEWINDER (Navy-Air Force)	GE-Philco, prime; Philco/GE guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; more than 2 m. range; conventional; new I-C models to have switchable IR and radar-guided warheads	Deployed with Navy and Air Force; all-weather type under development
★**SKYBOLT** (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle	ALBM; more than 1000-mile range; solid; nuclear; to be launched from B-52, B-70 and Vulcan bombers	R&D; to be purchased by British; operational 1964; test-launching to be from Eglin AFB, Fla. Add. funding restores old operational date
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear ramjet and warhead	Study-R&D
★**SNARK** (Air Force)	Norair, prime; Northrop, guidance; Pratt & Whitney/ABL, propulsion	Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear	One squadron of about 20 missiles at Presque Isle, Maine; to be eliminated
SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol, propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft earlier SPARROW I obsolete; new contract extending range, altitude
SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion	Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear	Estimated operational date: 1961. To be installed first on Thresher nuclear-powered attack submarine
SS-10 (Army)	Nord Aviation, prime; GE, U.S. licensee	Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa
SS-11 (Army)	Nord Aviation, prime; G.E., U.S. licensee	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional	Operational. Under evaluation by Army; decision on procurement due for some time
TALOS (Navy)	Bendix, prime; Bendix/Sperry, guidance; Naval Propellant Plant, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruiser Galveston
TARTAR (Navy)	Convair, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Operational on Missile Destroyer Adams in Oct.
TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs; HE warhead	Navy buying from Norway to equip two destroyer escorts
TERRIER (Navy)	Convair, prime; Reeves/FTL, Sperry guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid conventional	Operational with fleet
★**TERRIER-ADVANCED** (Navy)	Convair, prime; Reeves/FTL, Sperry guidance; ABL, propulsion	About 100% performance improvement over TERRIER	Operational with fleet; being deployed on destroyers and carriers
★**THOR** (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases set up in England. 66 military launchings: 45 successes; 11 partial; 10 failures. 48 scientific launchings: 40 successful, 2 partial; 6 failures

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★TITAN (Air Force)	Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range, 115 ft. long TITAN III proposed	32 launchings test vehicles: 21 successes; 7 partial; 4 failures. 8 bases for 12 squadrons planned; TITAN I scheduled to be operational mid-1961; TITAN II scheduled operational early 1963; first silo launch scheduled in May; first TITAN II in Nov.
TYPHON (Navy)	Westinghouse, prime; Bendix propulsion	Medium and long range seagoing anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Early R&D; may be used on hydrofoil destroyers
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Air-to-ground; low-level; solid; designed to climb over hills and trees	R&D
WILLOW (Army)	Chrysler, prime	Highly-classified missile	R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime Hunter-Douglas, propulsion	Air-to-air, air-to-surface; solid; unguided; 5-m. range; conventional	Operational

Space Vehicles

AGENA (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout; AGENA B stop-start 2450-lb. engine; about double fuel capacity of AGENA A	Used in DISCOVERER program; larger AGENA B also to be used with ATLAS and THOR
BLUE SCOUT (Air Force)	Aeronutronic, prime; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion	Solid multi-stage booster based on SCOUT components	Launchings 3: 2 successes; 1 partial
CENTAUR (NASA)	Convair, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	Pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, atop ATLAS booster, capable orbiting 8500 lbs. launching 1450-lb. space probe.	First test flight in 1961; first engine delivered
DELTA (NASA)	Douglas, booster; Bell, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor to THOR-ABLE; upper stage guidance; 480 lb. payload capacity	Interim launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe
JUNO II (NASA)	Marshall Center/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, propulsion	Early deep space booster; small payload	Phasing out
NOVA (NASA)	No prime announced; Rocketdyne, propulsion	Clustered 6-12 million lb. booster plus upper stages	R&D on 1.5 million lb. F-1 engines
ORION (Air Force)	General Atomic	Space booster launched by series of atomic explosions	Advanced engineering studies under way; tests may be attempted
PHOENIX (Air Force)	No contracts announced	Recoverable booster—possibly a modified F-1.	Studies
PROJECT 3089 (Air Force)	Aerojet-General, Grand Central, propulsion	Solid motor in 1 million to 2 million lbs. thrust class	Research determining feasibility; NASA contracting complementary studies with United Technology Corp.
ROVER (NASA, AEC)	No prime announced	First nuclear rocket: KIWI non-flying test engines and NERVA flight engines	Contracts to be let this year
SATURN (NASA)	Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and mid-stage engines; Pratt & Whitney, top-stage engines	Series of multistage vehicles based on 1.5-million-lb. clustered booster and various upper stages of LOX-liquid hydrogen engines. Early model to orbit 20,000-lb. payload	Second static tests ended; flight booster to be static-tested this spring for summer flight; flight with live upper stages scheduled 1963
★SCOUT (NASA)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion	Solid four-stage satellite launcher; 200 lb. payload in orbit	SCOUT 4 launched. EXPLORER IX Feb. 16. Four more SCOUT flights in '61 completes R&D; Navy proposing SEA-SCOUT for seaborne surface launch, would be based on POLARIS and SCOUT
THOR-ABLESTAR (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle, orbital capability 800 lbs. Upper stage has restart engine	THOR-ABLE phased out. THOR-ABLESTAR operational in TRANSIT and COURIER



Satellites in Orbit

EXPLORER I (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. Orbits earth; perigee 220 m., apogee 1122 m., period 106.7 min. (Discovered Van Allen Belt); not transmitting.

★VANGUARD I (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-1000 years. Orbits earth; perigee 407, apogee 2449, period 133.9; transmitting.

LUNIK I "MECHTA" (3245 lbs.) Russia. Launched 1/2/59. Believed to be in orbit around Sun on 15-mo. cycle; not transmitting.

VANGUARD II (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits earth but is "wobbling"; perigee 343, apogee 2053, period 125.4; inclination to equator 32.88°; not transmitting.

PIONEER IV (13.4 lbs.) U.S. Launched 3/3/59. Orbits Sun, and achieved primary mission—earth-moon trajectory; not transmitting.

EXPLORER VI "PADDLEWHEEL" (142 lbs.) U.S. Launched 8/7/59, est. life to Aug., 1961. Orbits earth; initial perigee 156, initial apogee 26,357, initial period 12½ hrs. present orbit uncertain.

★VANGUARD III (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits earth; perigee 322, apogee 2312, period 129.8; not transmitting.

★EXPLORER VII (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits earth; perigee 344, apogee 670, period 101.1; transmitting.

★PIONEER V (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits Sun, interplanetary environment probe; completed one full orbit 1/16/61; aphelion .9931 au, perihelion .8061 au; not transmitting.

★TIROS I (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits earth; picture-taking weather satellite; perigee 429, apogee 468, period 99.2; transmitting.

★TRANSIT 1B (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits earth; perigee 229, apogee 421, period 95.0. First R&D navigation satellite. Not transmitting.

★SPUTNIK IV (10,008 lbs.) Russia. Launched 5/15/60, est. life 2-3 years. Orbits earth; initial perigee 188, apogee 229—changed to 191/429 on 5/19; last reported—perigee 175, apogee 334, period 92.7. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed; payload, case and two pieces now in orbit. Not transmitting.

★MIDAS II (5000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years. Orbits earth; perigee 297, apogee 316, period 94.3. Telemetry for IR scanning failed two days after launch. Transmitting.

TRANSIT III-A (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits earth, perigee 389, apogee 650, period 101.6. Transmitting.

NRL SOLAR RADIATION SATELLITE I (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits earth; perigee 381, apogee 657, period 101.6. Not transmitting.

★ECHO I (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits earth; perigee 790, apogee 1139, period 117.1. First successful orbiting of passive communications satellite.

★COURIER 1B (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits earth; perigee 604, apogee 750, period 106.9. First successful launching of delayed active repeater satellite. Transmitting.

★EXPLORER VIII (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits earth, perigee 262, apogee 1410, period 112.5. Provides ionospheric measurements for communications. Not transmitting.

★TIROS II (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits earth; perigee 378, apogee 462, period 98.2. Transmitting.

★SAMOS II (4100 lbs.) U.S. Launched 1/31/61. Orbits earth; perigee 295, apogee 343, period 94.9. First R&D reconnaissance satellite.

★VENUS PROBE (1419 lbs.) Russia. Launched 2/12/61, aphelion 1.019 au, perihelion 0.7183 au. Expected to reach Venus by mid-April.

★EXPLORER IX (15 lbs.) U.S. Launched 2/16/61. Orbits earth; perigee 413, apogee 1587, period 118.3. A 12-ft. "polka dot" balloon.

★DISCOVERER XX (2450 lbs.) U.S. Launched 2/17/61. Orbits earth; perigee 176, apogee 463, period 95. No attempt to recover 300-lb. capsule because of malfunction.

★DISCOVERER XXI (2100 lbs.) U.S. Launched 2/18/61. Orbits earth; perigee 151, apogee 608, period 97.0. Carried IR equipment for MIDAS program to measure background radiation from earth.

★EXPLORER X (78 lbs.) U.S. Launched 3/25/61. Orbits earth; perigee 110, apogee 112,500, period 5012. Optical-pumping magnetometer.

★DISCOVERER XXIII (2100 lbs.) U.S. Launched 4/8/61. Orbits earth; perigee 183, apogee 394, period 93.9. Capsule ejected in wrong direction, sending it further into space. Transmitting.

★EXPLORER XI (82 lbs.) U.S. Launched 4/27/61. Orbits earth; perigee 301, apogee 1111, period 108.05. Measures gamma rays from the stars absorbed in earth's atmosphere.

★au:

(Orbital data is latest official information as of 1200 Z, April 25)

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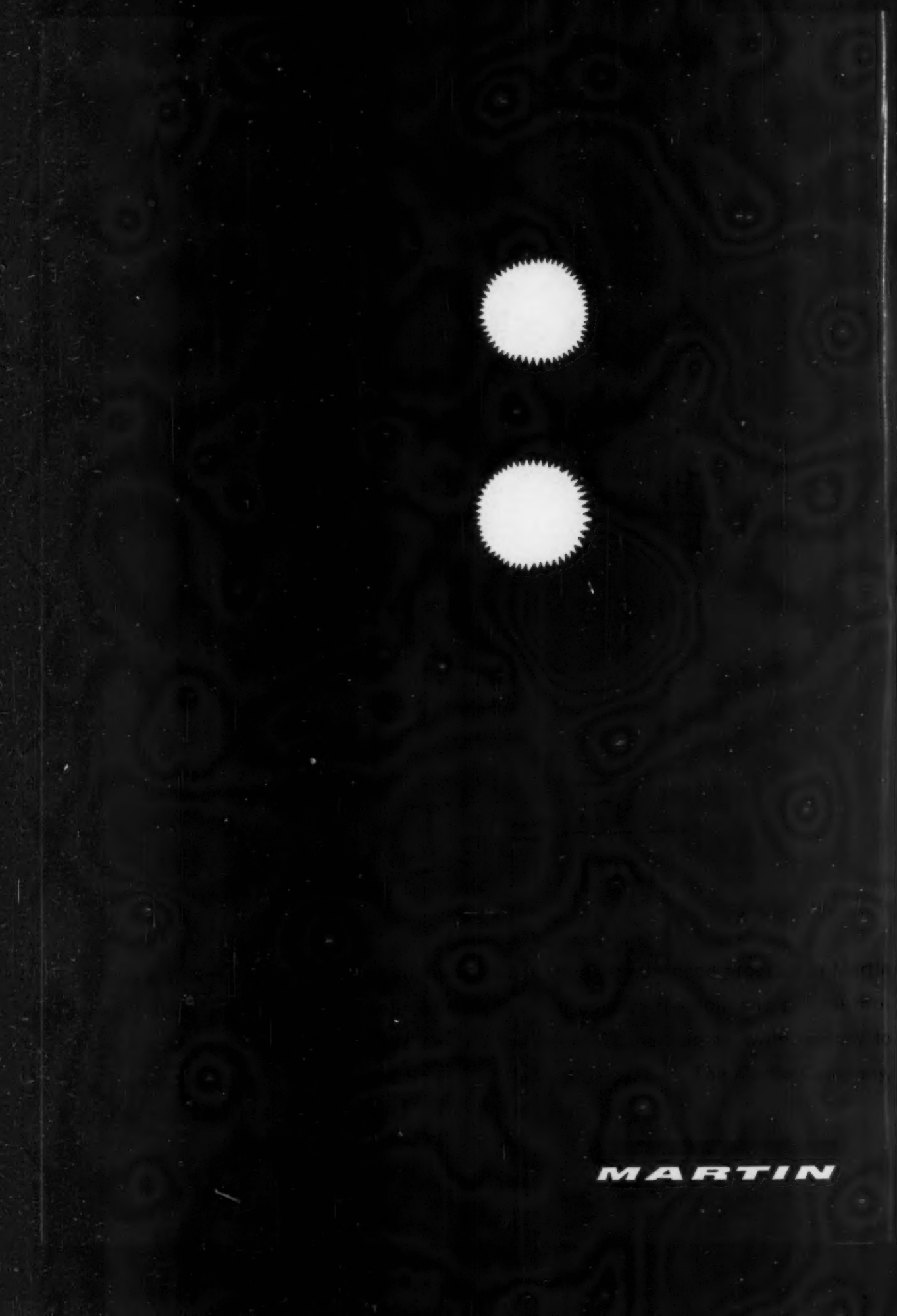
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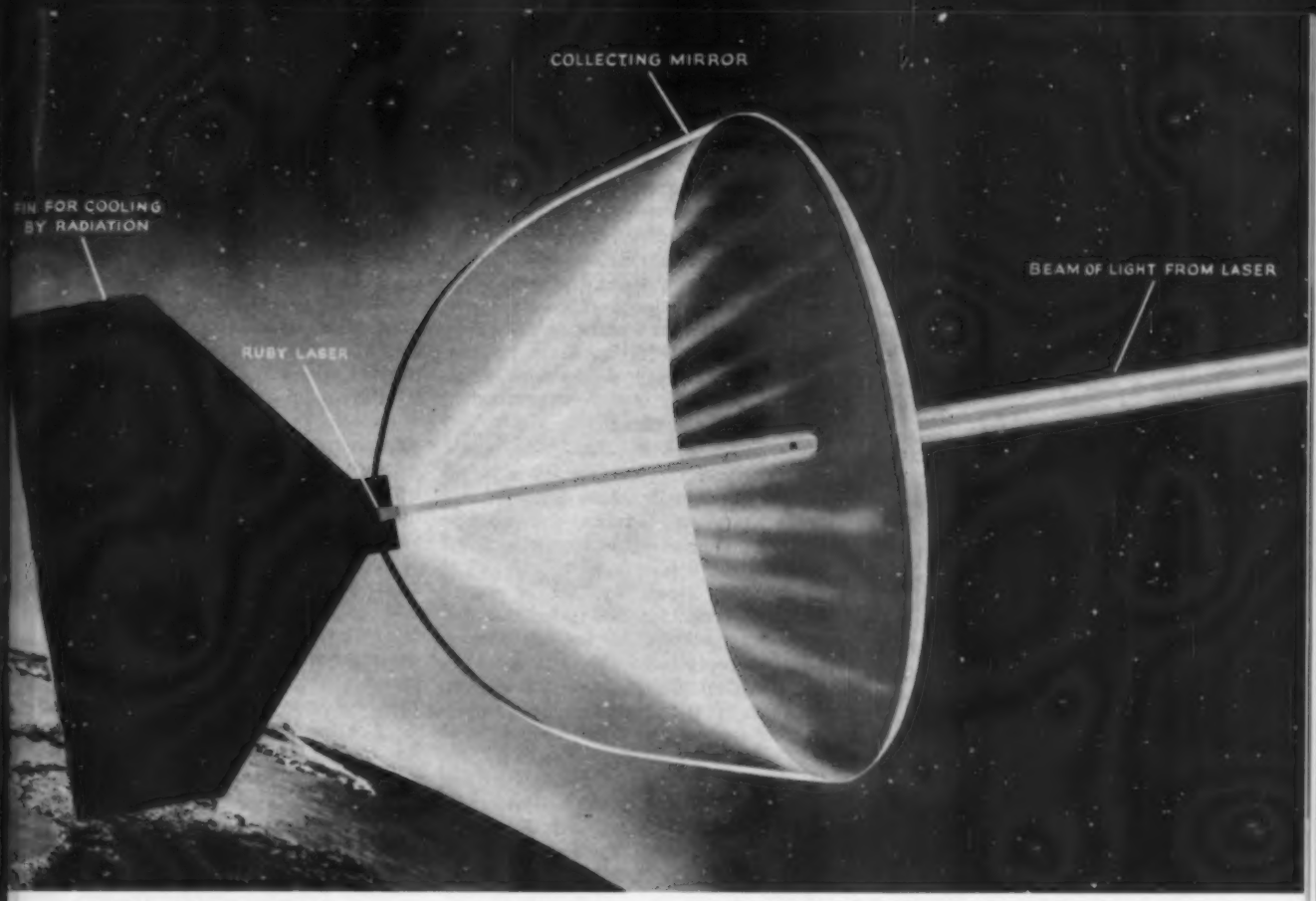


SUN-POWERED LASER for space communications (artist's conception) is being studied by American Optical for Air Force.

optics

Laser, Fiber Optics Technologies Join

by Charles D. LaFond

SOUTHBRIDGE, MASS.—Lasers and fiber optics, two new and seemingly divergent technologies, are slowly being drawn together.

Advanced research at American Optical Company's Research Center here indicates that glass fibers serving as dielectric waveguides might be used as a lasering medium. This might achieve laser action at relatively low-power levels, and provide mode selection and mode coupling surpassing a Fabry-Perot interferometer.

The Center is also studying, for the Air Force, the feasibiliity of building a sun-powered laser (using conventional synthetic ruby) for space use which would have a coherent continuous-wave output.

• **Merging sciences**—As these two technologies complement one another, so do the broad fields of electronics and optics. In the past, it has been the electronics manufacturer which has built up its optics capability. Now a countering trend has developed: the optics leaders are assembling an array of electronics and electro-optical specialists. Coupled with their already impressive majority of optics scientists and engineers, these companies can offer an imposing new body of talent.

With the development of lasers (light amplification by stimulated emission of radiation), the gap between optics and electronics is forever bridged.

The laser probably is the epitome of subtle union. With the parallel emergence of fiber optics, which offers a method of handling and carrying electromagnetic energy in the visible and infrared regions, the bridge is made indestructible.

Already, the drive is on to employ both developments in highly-advanced computers, communications, end-fire antennas and surveillance systems.

• **Space laser**—The present $91,000 contract held by AO from Wright Air Development Division, Dayton, Ohio, is for a one-year study to determine feasibility of a sun-powered laser system for space use.

There is significance in the unusual reaction time of WADD in its Request for Quotation for this contract. The RFQ was sent out in August of 1960—or roughly one month following the revelation of Dr. Theodore H. Maiman's laser development at Hughes Aircraft Co.

In the past, it has been shown that a laser requires 5000-5200°K equivalent temperature minimum from a black-body source. This has been readily available only from a flash tube. And, of course, the output is pulsating.

For space use, however, the sun offers an ideal continuous energy source since it radiates as a black body at 6000°K.

Under the present contract, AO will investigate three major components for a solar-driven ruby-laser system: the collector and associated optics, the laser, and the heat exchanger.

TRG, Inc., under a companion $30,000 WADD contract, will work closely with AO to develop a modulator for the system.

Contract requirements are necessarily broad. Types of subsystems are not specified and—except to consider a tentative collector size maximum of one square meter in area—AO can use wide latitude in studying all practical hardware configurations.

The optical considerations for optimizing such a system will receive heavy emphasis in the study, according to AO's Dr. Charles Koester. These will include collector configuration, filter assemblies, imaging optics, and whatever transmitting output optics are deemed necessary.

Not only will it be necessary to determine required image reduction for the best working energy intensity, but laser-output spread must be reduced as far as practicable below today's typical beam-spread of 0.5 degree. Improvements in laser material will be sought to further narrow beam-spread.

Also, studies will be continued to determine the best laser configuration for this space application.

Output requirement in the contract calls for 10^8 watts/steradian.

• **Problems imposing**—The problems to be surmounted in developing a practical sun-powered laser are numerous. Essentially, the overall task is to collect sufficient solar energy (radiation density is 1.38 kw/sq. meter) to produce the necessary energy density on the laser to effect inversion and cause the continuous-wave lasering.

So far, says AO project director Ed Dixon, the process itself is not completely defined because of by-products of heat which reduce the synthetic ruby efficiency.

The whole process, Dixon said, involves five principal operations: (1) collect the sun's energy; (2) reject unusable energy; (3) obtain the necessary energy density in the laser for pumping; (4) transmit the coherent induced emission; and (5) dissipate the heat energy.

Energy rejection involves the exclusion of energy beyond the useful absorption bands to keep the ruby at proper temperature (20°C). This could be accomplished with multilayer thin-film filters or with more conventional optical filters, Dixon said. A problem here is the prevention of filter deterioration near the focal point.

Pumping energy involves the basics of lasering. To achieve inversion (more ions in an excited state than in a lower state) using a typical synthetic ruby with 0.05% chromium doping, the pump must supply light in the absorption lines of ruby equivalent to a blackbody source of about 5000°K to start oscillation. Thus, energy losses must be reduced to the minimum to get an equivalent temperature.

Quantum efficiency of the laser is about 70%; therefore, in satisfying the heat problem, the useless 30% going to heat energy must be dissipated.

Also, re-emission is at a wavelength of 0.694 microns, while input wavelength is about 0.550 microns; thus the lasering process itself produces heat due to the difference in energy between a green and a red photon.

• **Fiber uses needed**—A burgeoning field such as that existing now in fiber optics actually forces development. So far, however, technical and production-technique advances appear to have outdistanced applications.

It is not, apparently, that the potential is unrecognized, but rather that the products marketed so far are almost all custom-produced. Despite this AO felt confident enough that a real market exists to create a separate department and sales group just to handle these new products.

Much of the present research in fiber optics is directed toward developing finer and more perfect fibers for more sophisticated uses. Rather than just light pipes, new bundles will be employed to handle frequencies in the visible portion of the spectrum—much as microwave is now carried in electronic systems.

A fiber optics bundle employs fine diameter glass rods to transmit light by repetitive internal reflections throughout the length of each.

In a single fiber, almost total reflection occurs if the surface quality is very high, thus preventing surface scattering. A typical 50-micron fiber reflects a light ray 3000-4000 times per foot.

But when two glass fibers are within a half-wavelength of light apart, light can leak from one to the other. By cladding each fiber with a thin jacket of transparent material having an index of refraction less than that of the fiber core, leakage is effectively stopped. Optical glass so far has proved to be the most effective light insulation.

By gathering the fibers into a bundle in such a manner that the fiber terminations are in the same arrangement at each end, image transmission is possible.

Bundles can be loose, fused, or fused and tapered. A tapered bundle enlarges or reduces an image as the ratio of its end cross-sectional areas.

The next step in its glass fiber optics development, says AO, is to evolve techniques and equipment for the mass production of fibers in varying sizes, materials, refractive indices.

The advances in fiber-optics development here have been significant over the past year. Finding applications and developing bundles for specific uses have not received the same emphasis. It appears that the technology has moved along much faster than could have been anticipated.

AO has successfully drawn arsenic trisulfide and assembled incoherent bundles for use in infrared detection.

At the same time, it has advanced the equipment used for drawing these clad fibers from limited laboratory-type to production-type.

Fifty-micron fibers having a 10-micron-thick cladding can now be drawn easily at a rate of 20,000 ft./min. with a single simple furnace. Scientists here are now attempting to build the first coherent bundle of arsenic trisulfide.

Currently, AO is developing a 5-in., fused fiber-optics face plate for a cathode-ray tube. Being developed under a WADD contract, the unit will permit contact photography of an image on a scope at about a speed 50 times faster than with conventional camera rigs.

• **Fiber laser next?**—The company has several projects now under way to determine the feasibility of a laser employing fiber optics for the lasering geometry.

According to Dr. Elias Snitzer, glass still looks like the best material for use in fiber bundles. More important, in this instance, it seems to offer interesting geometry for lasers, the scientist said, because it may permit obtaining a single mode necessary for coherent continuous wave propagation of light.

To achieve this end, Snitzer said, it will be necessary to reduce fiber cross-section and build up a good standing wave when the energy is pumped above threshold in the laser.

The basis, then, of the present program involves the use of fiber optics as dielectric waveguides to provide a resonant structure for mode selection in a laser system.

In a recent paper published in the *Journal of Applied Physics*, January, 1961, Dr. Snitzer stated that the mode coupling in such a dielectric waveguide would be intermediate between that of a Fabry-Perot interferometer (FPI) and a closed structure like a metallic waveguide.

While the fiber-optics laser offers better mode selection and stronger mode coupling than the FPI, it also has certain disadvantages. A major one, Snitzer noted, is that of getting pump power into the small-volume fiber.

He believes, however, that with proper fiber design and illuminating optics this can be overcome. Because of the better mode selection characteristic, pump power in the fiber is used more efficiently. Snitzer believes that laser

(Continued on page 45)

NASA Finds Solar Probe Is Feasible

Preliminary study covers trajectory, communications and power sources; high burnout velocity is seen as crucial factor

by John F. Judge

SPACE PROBES approaching as close at 4-to-5 million miles to the Sun are feasible if burnout velocities ranging between 50,000 and 100,000 feet per second can be attained.

D. W. Dugan of the Ames Research Center, National Aeronautics and Space Administration, says another prerequisite is that the capabilities of the instrumentation and communications system must be able to acquire data superior to the information obtainable from near-Earth satellites and ground observatories.

In a report on a preliminary study of a solar probe mission, Dugan says the nearness of the probe's approach to the Sun may be limited by the temperature tolerance of the structure or the instrumentation.

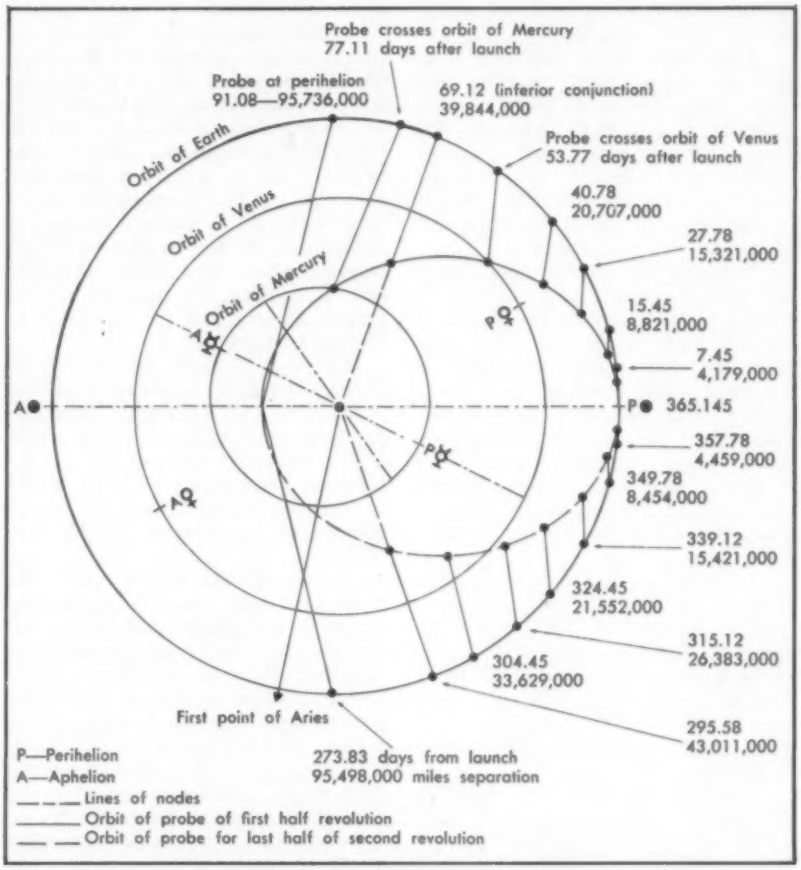
Although the temperature of the visible solar corona is estimated at 1,000,000°K, this portion of the solar atmosphere is apparently so tenuous that the passage of a body through it results in inappreciable deceleration and heating. In addition, the corona extends only a few solar radii from the Sun.

Heating of the probe from the relatively few collisions with corona particles may be negligible compared with that due to thermal radiation absorption.

Dugan feels that solar flares may have an effect, but data is so slim in this respect that such considerations were not included in the report.

The chief problem is the dissipation of solar-absorbed heat. Dugan says a spherical probe with uniform surface temperatures could approach no closer than 0.6 astronomical units.

• **Optimum probe configuration**—The next consideration is a specially oriented spherical probe which presents only one side to the Sun. At one extreme the rate of heat transmission might be considered great enough to maintain the unexposed areas at the same uniform temperature as the exposed area, creating a situation identical to the revolving sphere. At the other extreme, the two hemispheres could be completely thermally isolated—one side receiving maximum heat and the other being maintained essentially at absolute zero. This latter approach would permit operation somewhat closer to the Sun.



TRAJECTORY OF A PROBE which reaches its aphelion almost simultaneously with an inferior conjunction with respect to Earth and Sun. Time of launch is early January, when Earth is at perihelion, and cuts 1500 ft/sec. off similar summer launch.

Dugan maintains that higher ratios of radiating-to-absorbing surfaces can be achieved in a configuration consisting of a hemisphere followed by a right conical frustum. The longitudinal axis would be constantly pointed towards the Sun.

As far as the heating problem is concerned, this type of probe could function about 0.05 AU's from the Sun.

The report includes a preliminary study of the three-dimensional motion of a body launched into a hyperbolic orbit from the Earth in such a direction that it achieves an orbit of at least perihelion distance about the Sun.

In the discussion of his results, Dugan points out that the magnitude of the velocity requirements are quite large when compared with that for currently proposed Martian or lunar missions. Dugan says a six-month orbit is attractive because it passes well within the orbit of Mercury and close enough to the Sun that any data obtained would be of considerable value. In the second place, the six-month orbit has a total velocity requirement of about 54,000 ft. sec. This is less than that required to reach the orbit of any other planet or to escape the solar system altogether.

For a typical solar probe mission, launching errors which might normally be expected on the basis of current guid-

ance capabilities will be of little or no consequence. In the case of an orbit which is to closely approach Earth 1 year after launch, the initial guidance requirements are much more stringent. Depending on the closeness desired, mid-course guidance might be necessary.

The effect of other bodies on the probe in Dugan's restricted three-body trajectory study will be negligible if the time of launching is such that the distances of the probe relative to the moon, Venus, or Mercury as it crosses their orbits are sufficiently large that perturbations can be neglected.

• **Communications analyzed**—There are, of course, other considerations which need to be taken into account in planning a solar-probe mission, says Dugan. Some problems, such as attitude control and protection of vulnerable components against meteoroids, may be considered to be within the experience of current and past missions.

Provision for considerably longer life than heretofore required will be necessary, but this does not appear to demand much more than some relatively moderate increase in weight. On the other hand, inasmuch as a solar-probe mission presents problems in communications not found in current missions, Dugan questions whether it is possible to solve these problems without entailing such great power requirements and weights that the mission becomes impractical.

The chief problem is the tremendous distance over which communications need be maintained. The distance between the Earth and probe at perihelion of the latter is of the order of 10^8 miles. Galactic background noise, solar noise during periods near inferior conjunctions, and Doppler effects present other difficulties.

The rate at which data would be transmitted from a probe is not likely to be only a few bits/sec., since to justify a solar-probe mission the accuracy and amount of information should be greater than that which could be obtained from near-Earth orbits. Dugan did not attempt an analytic treatment of the whole communications problem. Rather, a look is taken at the present and anticipated state of the art of deep-space communications and of auxiliary-power generation to obtain an order-of-magnitude estimate for the weight which might be required to provide the power for adequate communications in a solar-probe mission.

• **Ground support** — Considerable effort is currently being made to achieve adequate deep-space communications for future interplanetary missions. A number of facilities, devices, and techniques being developed for this purpose show promise of extending the range and usefulness of communications for space missions for modest power costs.

Among these Dugan mentions the construction of several large, steerable ground-based antennas; the development of a steerable spaceborne antenna of moderate gain; the design of stable oscillators of very-high frequencies; the application of masers to reduce receiver noise to very-low levels; and the application of information theory to increase the amount of information which can be carried on a communication channel of given bandwidth.

It was estimated that within a four-year period, the communications system used in the lunar mission *Pioneer IV* could be extended to provide a two-way link over a distance as large as 4×10^9 miles with a transmitter output power of 100 watts and a receiver bandwidth of 30 cps. An Earth-seeking vehicle antenna with a 36 db gain was assumed in the estimate. If the frequency of 960.05 megacycles/sec. used in the lunar mission is retained the diameter of this vehicle antenna can be calculated to be approximately 27 ft.

For a solar probe, the antenna diameter should be no larger than that of the probe itself if provision for shielding from solar radiation is not made. There may be an optimum size for the antenna such that the ratio of the weight of shielding required for thermal protection has a maximum greater than unity.

Dugan assumes that the probe antenna is no more than 3 ft. in diameter. A simple calculation then shows that the two-way communications system described, but with the smaller probe antenna, would require a transmitter power output of about 5 watts to have a range of 10^8 miles. If the transmitter efficiency of 7.5% obtained in the *Pioneer IV* experiment were not improved in the time indicated, the required input to a vehicle transmitter would be nearly 70 watts.

It is possible that the bandwidth would need to be increased two- or three-fold to meet requirements of a minimum information rate in a solar-probe mission. This would require greater transmitter power, two-fold for a two-fold increase in bandwidth, etc. In any case, in view of the rapidly advancing state of the art of deep-space communications, the spaceborne power requirements for communications in a solar-probe mission can be expected to be only a few hundred watts at the most within the next few years.

• **Power requirements**—Because of the extended time characteristic of a solar-probe mission, some type of power converter rather than chemical batteries will likely serve as the primary source of power.

The solar cell is not well suited to a solar-probe mission. The efficiency of this device decreases with increasing temperature, and measures used to prevent high temperatures of the cells tend to decrease output or to increase weight, says Dugan.

Other types of solar-energy converters are currently being investigated or developed. Some of these show promise of achieving attractive specific powers (watts/lb.). As an example, Dugan refers to a thermionic converter said to have produced 7.2 watts/lb. in an experimental setup, and to be capable of 17 watts/lb. in the future. One type of thermionic converter is reported to be in commercial production, to be followed by an improved version at a later date. The output of the latter type may reach 20 watts per square centimeter of cathode surface, and the thermal efficiency may be as high as 30%.

Dugan says the close relationship between solar activity and terrestrial phenomena—such as polar auroras, magnetic storms, disruption of radio communication, climate and weather—is currently recognized but the causality of the relationship is not completely understood.

In addition, solar events themselves are not adequately explained or predicted on the basis of present knowledge. Partial information is available on the corpuscular and radiative output of the Sun and the nature of the magnetic and electric fields of circumsolar space.

An instrumented probe could effectively fill this gap in data. ⌗

NOL Drop Tester Seen Trimming Costs by 90%

AN INEXPENSIVE portable shock tester developed by the Naval Ordnance Lab., Silver Spring, Md., is expected to save 9 out of every 10 dollars now being spent to insure shock reliability in electronic components.

The prototype model cost about $5000 to build, but it replaces a permanent drop-tower valued at $50,000. The new instrument can subject components weighing upwards of 100 lbs. to shocks in the area of 10,000 gravities.

The drop-tester consists of a 900-lb.-base and anvil connected by two pipe columns to a sliding carriage designed to hold the specimens.

Glass-bead shock mitigators isolate a lightweight lifting yoke mounted on the carriage.

In operation, the device is lifted to the desired height by a hoist or a mobile crane. As it raises, the carriage separates from the base. When the tester is dropped, the base plate strikes first; a fraction of a second later, the carriage strikes the anvil, transmitting shock to the specimen. ⌗

DOD Revision

(Continued from page 18)

is the forces provided in the President's budget for FY 1962.

Initially, these forces will not have to be costed out in program package terms. But during the summer, as force proposals are submitted to the Secretary, he will want to see the program package cost implications of the alternative of continuing each force as projected. The assumption for this exercise will be issued shortly.

No one expects this force structure to be the actual one. These forces are simply present forces and weapon systems continued into the future (except where a phase-down has already been decided), with no new ones except those already funded (and a few others already approved by the Secretary), and no new equipment (again except that already funded).

This does give us a base from which to start. Clearly there will be subtractions from the base as we go along, as well as many additions.

For each program package, therefore, and where feasible and appropriate for program elements within the package, we will want the following cost information (obligational authority and expenditures; also numbers as well as cost of military personnel):

(1) How much in 1962 budget?

(2) How much implied in the specified benchmark force structure, '63-65?

(3) What alternative programs (forces, capital expenditures, etc.) do you propose, and how much will they cost—for the next 5 years? (Or more in a few cases, where appropriate.)

In general, we shall be relying on the Services to design and present imaginative proposals both for "add-ons" and reductions responsive to the general policy guidance provided by BNSP. But the Secretary will also be interested in seeing other alternatives. These will be specified in the program guidance for each program package.

• **A "Big Board"**—Finally we shall issue a schedule for program submittals so that the Secretary and his advisors can examine and make decisions on program proposals in an orderly way over a period of several months. The submission of program proposals for review by the Secretary of Defense and his staff will begin approximately June 1st. As the program packages are reviewed, the Office of Programming will advise the Secretary on the resource implications of some of the alternatives submitted.

A special program cost analysis group is being established in my office to review program element cost submissions by the Services. The Secretary will examine the program submittal and make tentative program decisions to be used in preparing the FY 1963 budget.

As program packages are approved and program decisions made during the deliberation process, a "Big Board" will be set up by the Office of Programming and thereafter maintained on a current day-to-day basis. After all program decisions concerning the FY 1963 budget have been made, the "Big Board" will reflect the total Defense structure in program package terms. As changes, deletions, additions or any other deviations from the original total of packages takes place, the Board will be so revised.

In costing end-product programs, I have said that we want the full budgetary implications included. But we also realize that we have to do what is feasible and practical this year, and that this will have to be done using statistical factors in most cases.

The question is how far and deep should one go into the support structure, for example, in tracing the cost implications. The general rules are:

(1) Try to prorate (take "slices") if the overhead or support activity varies directly with the force unit or weapon system (e.g., specialized training, spares, maintenance): but if the overhead or support activity doesn't vary, don't prorate it (e.g., academies, colleges, higher headquarters).

(2) Be very explicit about what is and isn't included. We realize that some support elements that ought really to be prorated will not be able to be this year. However, we intend to pursue this and do a better job next year.

I do want to emphasize that while statistical cost factors will be acceptable for program decision-making purposes, we do not intend to forget about the cost estimates used for program decision-making purposes when we reach the budgeting phase. Substantial discrepancies will be called to the attention of the Secretary and may necessitate revision of the program decisions.

• **Oct. 1 deadline**—This is an ambitious program. However, one of the things that gives one some confidence that we can manage a program review along these lines is that the Weapon Fact Sheets for FY 1962 which include only 145 weapons and items of equipment, account for about 75% of the procurement appropriations and about 45% of the RDT&E and the construction appropriations. Of course, as we all know, the difficult areas for this approach are operation and maintenance, and military personnel.

We expect to complete the programming phase not later than October 1, 1961. The tentatively approved program packages will then form the basis for budget submissions in the usual fashion by appropriations. The total budget will then be reviewed and recommendations made to the President by early December.

I want to emphasize that the program package concept for review and decision-making as directed toward the FY 1963 budget is only the beginning of the formulation of a continuing planning and programming/financial management process. We visualize a continuous process of review and revision to improve the system.

Toward the longer-term objectives of an integrated programming and budgetary system, the Office of Programming with the assistance of contractor personnel and consultants, will begin to test the adequacy of presently existing information systems by estimating the cost of some of the more difficult resources elements such as construction, operation and maintenance, personnel and training associated with the FY 1963 program packages.

This will take place during the late spring and early summer of this year. This effort will then be expanded during the fall and will require full participation of the Services. Broadly, the sequence and nature of this phase of activity will be along these lines:

First, we will study and define types of information, both financial and non-financial, necessary for making the top management program decisions. Then against these requirements, and with the assistance of knowledge gained in connection with the FY 1963 package work, information presently available at the OSD level will be thoroughly surveyed.

In parallel with the data survey, the Programming Office will try to design a system for clear and concise display of program package information for the Secretary of Defense and his staff on a continuing basis.

Following these steps, all military department information systems will be reviewed in order to determine the extent to which information is available or can be reoriented toward meeting the requirements of management decision information. Where the requisite information is determined to be unavailable, study will be generated in order to recommend means of acquiring it. We anticipate that this activity will continue until approximately 1 Dec., 1961.

Based on the FY 1963 program package work and the Programming Office/military departments/contractor study results, improvements will be initiated on the program packaging concept and the data systems for continued programming/financial management purposes.

We will try to guide this activity from December 1 of this year forward so as to make significant improvements in the concepts and systems that I have been discussing in time to accommodate FY 1964 program guidelines. ⌗

Republic Plant Has 7 Specialized Labs

Center geared to making sure company maintains its balanced capabilities for DOD contracts

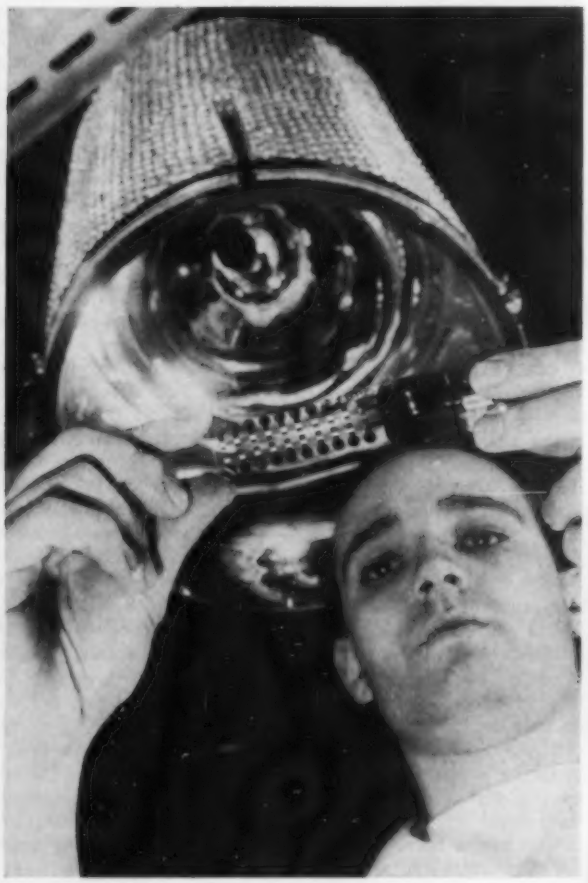
REPUBLIC Aviation Corp. made a down payment on Space Age insurance late last month when it dedicated its $14-million Paul Moore Research & Development Center in Farmingdale, N. Y. (M/R, March 21, 1960, p. 14).

The company wants to assure itself of continuing Department of Defense and NASA contracts, which more and more often are going to firms able to show their capabilities beforehand.

Each of the Center's seven laboratories is designed as a self-sustaining unit competent to solve a particular set of Space Age problems. The fields of specialization are: space environment and life sciences, re-entry simulation, materials development, nuclear radiation, guidance and control systems, fluid systems, and electronics.

Furthermore, each laboratory is set up to compete for contracts with any

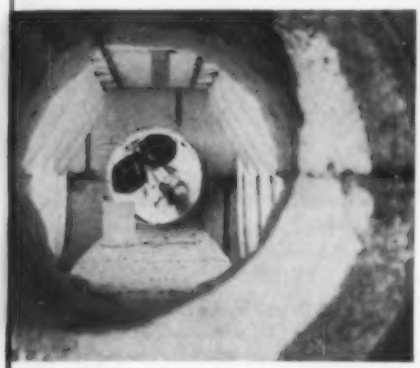
TWELVE-INCH optical flat mirror, part of a 15-ft.-long auto-collimator, provides a parallel beam of light 16 in. in diameter for Guidance and Control lab's optical system tests.



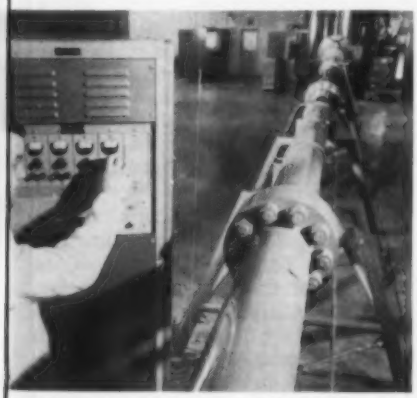
ELECTRONIC capacitor less than one-millionth of an inch thick is made under the thimble-shaped dome of a special vacuum-coating machine.

other facility in the country. In this way, Republic feels it can keep abreast of fast-paced technology and at the same time have the research laboratories possibly pay their own way.

Moreover, Republic says, the laboratories can be integrated to give the company a broadband capability for bidding on major weapon systems studies, submitting proposals and performing on contracts. ⌗

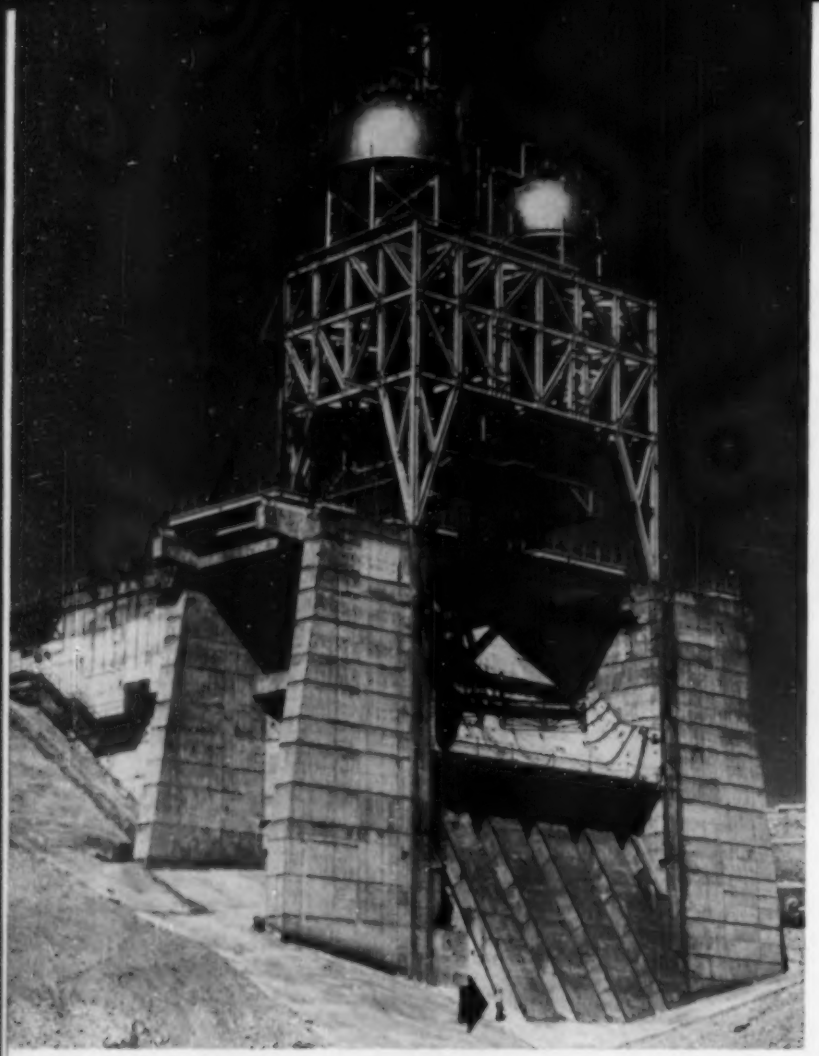


MATERIALS laboratory technician observes ceramic specimen undergoing heat treatment in special furnace able to maintain 3000° F for several days.

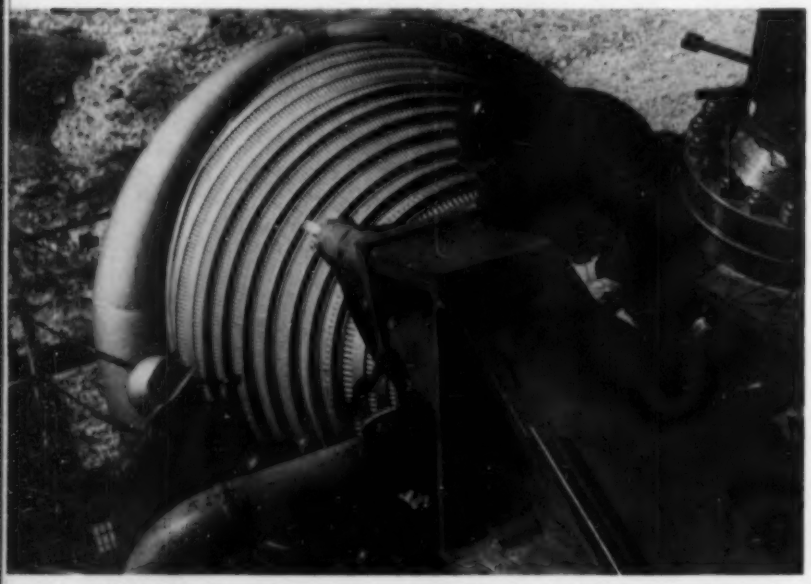


HIGH-PRESSURE (100,000 psi) combustion-driven Mach 20 shock tunnel, in Re-entry Simulation lab, has windows for observing re-entry effects.

THIRTY-FOOT-LONG altitude chamber, part of Space environment laboratory, is said to be only unit of its size able to simulate altitudes of more than 150 miles for testing men and systems.



TEST STAND 1-B as it nears completion. Huge structure, more than 250 ft. high, can be used for testing clustered F-1's. Note size of man (arrow).



HIGHEST THRUST ever achieved in U.S.—1,640,000 lbs.—poured from this chamber April 6 in test series preparing for firing of complete F-1.

propulsion

Preparing For All-out F-1 Tests

Last of three big stands nearly finished; costs cut by water recovery

by Richard van Osten

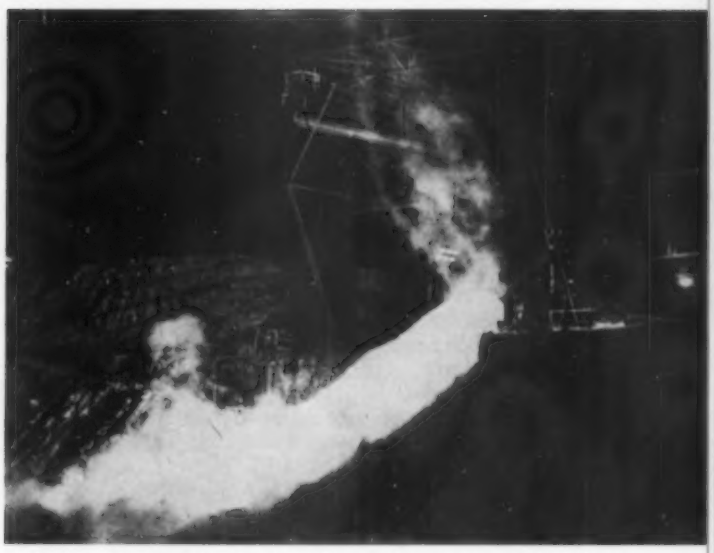
EDWARDS AFB, CALIF.—Test facilities for the 1.5-million-lb.-thrust F-1 space engine are rapidly being completed for the first full-scale firing in July.

Some 30 to 40 thrust chamber runs have been made so far, with both the boiler-plate development model of the Rocketdyne/NASA powerplant and a prototype of the fuel-cooled thrust chamber. The latter, with a 10:1 expansion ratio, has been tested in several runs under 20 seconds to more than 1.6 million lbs. thrust since the first high-thrust run in early April. All these runs have been made on Test Stand 2-A, which was completed last June.

The next test series, first in the full-scale engine firings, will be made this summer on Test Stand 1-A, the second stand in the three-stand F-1 complex. Fuel and LOX supply systems for this stand will allow firings up to about 150 seconds, as compared to present thrust-chamber-only runs of less than 15 seconds. The stand, however, has no provisions for gimballing the vertically mounted engines during test, and will be used for static tests at something less than the hoped-for maximum thrust.

• **Ultimate test**—The real "boomer" will come on Test Stand 1-B, now nearly completed. This stand will handle two F-1 engines. It also has provisions for gimballing during test runs. Rocketdyne engineers say, however, that present

TEST STAND 1-A, second stand in the three stand F-1 complex, where first full-scale firings will be made.



PROTOTYPE thrust chamber for F-1 spews flames of more than 1,000,000 lbs. thrust in Edwards firing. Chamber has reached 1,550,000 lbs.

plans do not call for firing of more than one engine at a time. Stand design incorporates provisions for expansion to F-1 cluster firings when the program requires it.

Stand 1-B is over 250 ft. high and contains 26,000 cubic yards of concrete. Two 35-ft.-diameter tanks, mounted directly over the stand, hold 75,000 gallons of LOX and 60,000 gallons of fuel (RP-1), respectively. The LOX tank is a stainless-steel, double-wall, vacuum-jacketed unit. Because of their size, both tanks were weld-assembled at the site from pre-fabricated "orange peel" segments.

Cooling water for the stand is contained in a 1,000,000-gallon tank located on a hilltop above the facility. During a full-thrust run, six 1000-hp pumps push the water through a 5½-ft.-diameter pipe to the test stand at 75,000 gallons per minute.

Because the large amount of water required for the big stand poses a major problem in the desert area, a recovery system is used. Located in a dike-type runoff pool below the flame deflector, the system includes a skimmer to lift off any unburned fuel from the water's surface and route it to a small sump area for burning. The remaining water is pumped back to the large storage tank. This system is expected to recover slightly over 40% of the water used in each firing.

The flame deflector is unique in that cooling water is carried through 2-in.-diameter tubes from the top of the deflector to about halfway down the curved deflector surface. At this point, the water runs free from open tube ends for the balance of its trip down the deflector face. In essence, the system provides radiation cooling in areas closest to the engine nozzle, and spray cooling to the lower areas.

• **Moneysaver**—Designed by Rocketdyne, the system is reported to have cost some $75,000 against an approximate $440,000 for the more conventional cooling approach. In addition, maintenance costs are reduced because the tubes may be individually replaced, eliminating patching and welding time and the costs involved in repairs to a standard-form deflector.

When full-scale F-1 tests get under way, Rocketdyne expects to be making seven or eight engine runs per day. This, they hope, will be accomplished by the years' end. Each engine may be run at frequent intervals for as long as a month.

To support this proposed program, about 200 tons of LOX per day will be required. The existing LOX plant at Edwards can produce only 140 tons per day. A new NASA LOX plant is now under construction which will have a capability of 2000 tons daily. The LOX will be piped to the stands through vacuum-jacketed pipes.

Fuel is carried into the F-1 test site by tank cars, and stored in a 120,000-gallon tank. It is piped to each test stand as required.

• **One-day charging** — Although a high rate of F-1 engine testing is planned—with each engine remaining on the stand for several weeks, if all goes well—the big 1-B stand has been equipped with plug-in instrumentation and other connections. Wiring, pneumatic and fluid connections, where applicable, are pad-mounted with a system of quick-release connectors. It will require about one day to change engines; the engine itself can be changed in four hours, but connection and checkout of the match panels will take up the balance of the time.

During full-scale tests, between 100 and 200 critical engine parameters will be measured. All data will be transmitted from the test stand area to the control room by means of instrumentation wiring trays in walk-through tunnels which also provide access to the F-1 area test stands.

From the control center, the data will be transmitted in cryptographic form by teletype to Rocketdyne's central data processing center in Canoga Park, Calif., where it will be analyzed by preprogramed computers and returned almost immediately to the test engineers at Edwards. ⌘

Canada Steps Up Space Exploration

CARDE heads national push based on use of Black Brant series of rockets; details of solid-making process

by Bernard Poirier

CANADIAN SPACE efforts during the next 12 months will feature advanced rockets for heavy payload probes into the ionosphere and a unique "long-legged" earth satellite to be launched in early 1962.

Spearheading the nation's drive is the Canadian Armament Research and Development Establishment (CARDE). This group recently flight-tested *Black Brant II* solid-fuel rockets designed to lift 150-lb. instrumentation to altitudes between 150 and 180 miles from Fort Churchill Rocket Range, Manitoba.

CARDE, moreover, will be "design authority" for new solid *Black Brant III, IV* and *V*. Prime contractor will be Bristol Aero-Industries Limited, of Winnipeg. Version *IV* is Canada's first serious two-stage effort and will lift payloads up to 250 lbs. for sub-polar probes as high as 600 miles.

Canadians said last week "numerous *BBII* vehicles will be available for a 1961 series of shots." The Bristol series is scheduled to follow the Canada-NASA satellite launching from Vandenberg AFB, Calif., as part of the two nation *Top-Side Sounder* program. (M/R, April 24, p. 18.)

CARDE and the Defence Research Telecommunications Establishment (DRTE), both under the Defense Research Board (DRB), have guided existing rocket propulsion development, satellite design and launching techniques at the Hudson Bay testing area. Program acceleration is expected with the addition of direct management by the Department of Defence Production and Bristol Aero-Industries.

The Associate Committee of Space Research of the National Research Council is coordinating test planning for experiments which will include pressure measurements by Toronto University's Institute of Aerophysics and falling-probe electron-density measurements by the University of Saskatchewan.

MISSILES AND ROCKETS learned the first details of CARDE's solid-propellant processes designed to maintain controlled particle size distribution in an uncaked state for six weeks or more.

• **Exclusive report**—The oxidizer process provides discrete, free-flowing and surface-dried blending of ground and unground ammonium perchlorate. A prepolymer adduct of a polyurethane binder is synthesized from the triol and totylene diisocynate in glass-lined closed pots.

The prepolymer is blended with the main diol and the remainder of the isocyanate in the propellant mixer. In reply to a query on the method, CARDE Acting Chief Superintendent at Valcartier, P.Q., R. F. Wilkinson disclosed that CARDE designed a new "3000-lb. horizontal mixer incorporating several unique features."

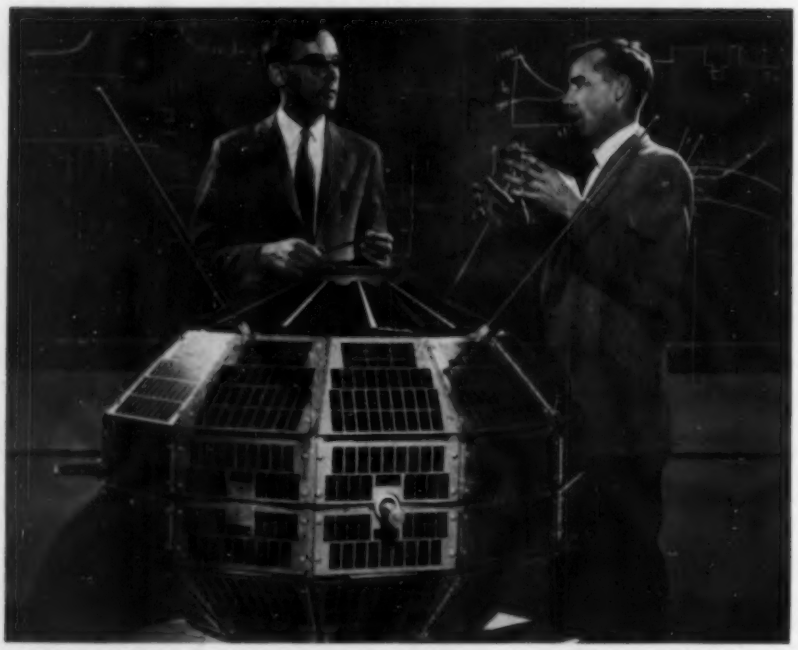
With its own transfer wheels on a 54-in. track, the mixer forms a vacuum seal and dumps the propellant into the engine case at the casting site. Internally, the ribbon has a double blade to blend the crystalline oxidizer and liquid binder and to feed the propellant towards the centrally located dumping valve.

Once vacuum-cast in an inhibitor-coated engine case, the mixer is withdrawn for solvent cleaning. The rocket engine is later capped and hot air is circulated between the casting bell and the engine case for curing at programed temperatures to 130°F.

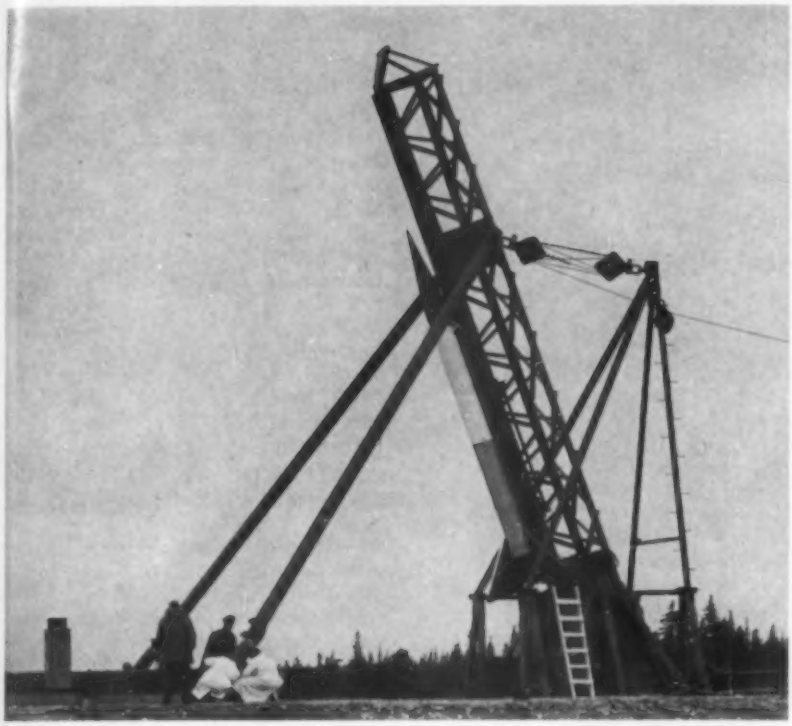
The casting mandrel is withdrawn from the rocket engine, approximately 19 ft. long and 17 in. ID, for inspection against non-adhesion, cracks and other anomalies. A barricaded CARDE control console is used to minimize personnel hazards in mixing, blending and curing operations.

• **Reliable fuel is aim**—According to DRB spokesmen in Ottawa, *Black Brant II* was designed with reliability as the primary objective; payload/altitude is secondary. They said two rockets have been tested and "the maximum longitudinal acceleration measured at all-burnt (burnout) was 16.7 g with maximum laterals of 1.2 and 0.87 g."

The vehicle answers requirements



TWO 75-FT. ANTENNAS are unique features of Canada's satellite design for the joint Canada-NASA Top-Side Sounding project. A NASA rocket will place the satellite into orbit from Vandenberg AFB, Calif., in early 1962. Above, Dr. John Barry and Dr. Colin Franklin (center), of the Satellite team from the Electronics Wing of the Defence Research Communications Establishment, discuss Canada's space plans.



BLACK BRANT I has been used heavily in Canadian space research. Black Brant II is only slightly larger, but has greatly increased payload capability.

for an inexpensive Canadian instrument to continue the space studies in which *Nike-Cajun*, *Aerobee-150* and *Black Brant I* rockets have already been used.

Its reliability objectives are now accomplished, and *Black Brant II* also increases altitude performance by about 150% and payload capability by almost 100%. (M/R, Oct. 3, 1960, p. 25.)

The new vehicles are expected to use the existing 15 ft. underslung, zero-top off launcher at Fort Churchill. The launcher is fixed in azimuth on a bearing of 093° true, with elevation angles between 60° and 85°.

The launcher is exposed, and Rupertland climate factors restrict the time of year when satisfactory launching conditions exist. As a result, the first 1961 series of shots may not take place before the end of May.

One of the principal tracking stations for use with *Black Brant II* will be the ICBM Warning installations set up by DRB/USAF at Prince Albert Radar Laboratory, Saskatchewan. PARL has also been identified as one of the ground receiving stations for Canada's 1962 satellite project with NASA.

Scientists from DRTE, MIT's Lincoln Laboratory, Canada's Research Medical Laboratories at Downsview, Ontario, the Dominion Observatory and the Department of Transport have figured prominently in preparations for Canada's first big year in space research. Further related studies may also be sponsored at Suffield Experimental Station near Medicine Hat, Alberta.

• **New version heavier**—Appearance of *Black Brant II*, whose design study was ordered in 1959, differs only slightly—the *BBII* has a 11½° nose cone angle compared to 15°, which explains the increased payload area. Other differences are:

	Black Brant I	Black Brant II
Overall length	292.0 in.	332.0 in.
Nose cone length	62.3 in.	86.0 in.
Burning time	20 secs.	26 secs.
Thrust	20,000 lbs.	16,000 lbs.
Tot. Imp. sec. lb.	400,000	420,000
Engine weight	1758.5 lbs.	2095.0 lbs.
Filled total weight	2492.8 lbs.	2782.3 lbs.
Payload area cu. ft.	4.0	6.2

The conical and forward body section of *BBI* is skinned with 12 SWG 4130 steel and the afterbody section is cast in DTD 304 light alloy. The conical and forward body section of *BBII* is cast magnesium-zirconium EZ33A in thicknesses from 0.5 in. fw'd to 0.45-0.38 in. aft, with 0.40 in. on the body section.

• **Plastic nozzle research**—*BBI* fins use DTD 368 web and spar wooden matrix structure with steel skins covered with a phenolic-soaked durestos material. The leading edge is cuffed with stainless steel and the fin ring is a high-strength, light-alloy DTD 683 casting.

BBII uses magnesium alloy EZ33A sand castings for the central section with insert leading and trailing edges in NEMA Grade AAA laminated phenolic asbestos. The fin roots are flaired and bolted to a central support ring, which in turn is bolted to the rear engine face.

CARDE nozzles are 4130 steel for body and expansion cone with graphite insert in the throat. Metal surfaces exposed to hot-propellant gases are oversprayed with 0.005-in. ceramic. It has been found satisfactory to use steel as a heat sink to maintain surface temperature below 500°F.

One DRB spokesman described the CARDE-designed nozzle as "weighing 43 lbs. compared to 70 lbs. for a corresponding commercial nozzle." He added, "Plastic expansion cones and complete plastic nozzles are being developed to further reduce the weight in this rear position." ¤

Lasers & Fiber Optics

(Continued from page 34)

action should be initiated at power levels well below that of an FPI cavity.

Solving the problems in such a system development will depend considerably on finding the right laser material. Many materials are difficult or even impossible to draw into the desired shape and size.

• **Wavelength studies**—In his experiments in the study of dielectric waveguide modes in the visible spectrum, Snitzer has used clad fibers with core diameters from 0.1 to 5.5 microns. Core and cladding indices of refraction were 1.56 and 1.52, respectively.

Cladding diameters in each case were 100 times core diameter. The outer surface of the cladding was painted black to absorb stray light from within.

Fibers were finally encapsulated and ends were cut, ground, and polished. Overall length was approximately one inch for all mounted fibers.

In the tests, fibers were illuminated with monochromatic light with a medium-intensity carbon arc source.

With a suitable optical configuration and with proper choice and adjustment of the illuminating beam, Snitzer was able many times to obtain single modes. More important, his observations when identified very closely approximated the predicted wavelength for each preselected mode.

This work is being carried out under a contract with AF Cambridge Research Center to investigate the use of fibers in the study of dielectric end-fire antennas. Such simulations will permit making radiation measurements in the laboratory quickly and easily by means of simple photographs. ¤

soviet affairs

By Dr. ALBERT PARRY

Pregnancy in cosmonaut-women

and virility in cosmonaut-men may well be the subjects of space-medicine research in Russia as Soviet scientists prepare their next pilots for orbiting. It should not surprise us if a Russian woman is soon launched into outer space and, on returning to earth, is presented as a happy and healthy mother-to-be. The effects of radiation and other outer-space conditions have already been studied by Soviet space specialists in the reproductive organs of Marfushka ("Little Martha"), the female rabbit who was sent up ballistically and successfully recovered on July 2, 1959. And the female dog Strelka ("Little Arrow"), who orbited the earth in Spacecraft Two on August 19, 1960, gave birth to six sturdy pups in November.

At the press conference

of the Academy of Sciences in Moscow on March 28, 1961, as Strelka and her healthy pups were proudly exhibited, Academician Norair M. Sisakian, a noted biochemist, announced: "All six of Strelka's progeny are developing normally. The mother has manifested all the traits that go with the usual maternal behavior. Our research on these animals, just completed, has proved that no dangerous consequences to the functioning of their organs have stemmed from the space flight. This problem has an important bearing on our preparations for man's orbiting."

The flies taken

on the same outer-space trips in 1960-61 have been subjected to "researches of genetic character," which evidently have been no less successful. These researches also augur well for man's reproduction of his own species as a new cosmonautic race—says Professor Vasily V. Parin, a prominent member of the Soviet Academy of Medical Sciences in charge of outer-space physiological research.

Weightlessness with comfort

was described by Major Yuri Gagarin as lasting the entire 89 minutes of his flight in orbit on April 12. Gagarin apparently had experienced some brief moments of weightlessness during his training period, probably in an airplane much like the Air Force C-131 which by climbing in a ballistic trajectory following a steep dive can produce about a half-minute of weightlessness. An official Soviet report of April 25 described the preliminary training experiences as: "It was established that all the selected cosmonauts possess a good ability to endure weightlessness. It was also shown that, under the conditions of weightlessness lasting up to 40 seconds, the cosmonaut can eat food liquid, semi-liquid, and solid; can perform delicate coordinated acts, such as writing or purposeful hand motions; can maintain communication by radio; can read; and, besides, can orient himself visually."

Rocket fuel making

is the subject of a play written by Nicholas Virta, a Soviet author, and currently staged in a Moscow theater. The title is *The Sky Is High in the Summer*, and the second act takes place in a Russian rocket-fuel laboratory. The *Izvestia* reviewer declares that this particular act "has turned out to be the weakest," even though its aim is to show "the dramatic quality of scientific search." The play's text is as yet unobtainable outside the Soviet Union.

The latest dictionary

of Russian and English rocketry terms has just come out in Trenton, N. J. It is A. Kramer's *Russian-English Rocket and Ballistic Missile Dictionary*, containing more than 10,000 words. The book also has a useful list of reference works—Soviet dictionaries and scientific magazines—with the aid of which the Russian-American author, an engineer graduated from a Russian polytechnical institute, has prepared his volume. (For a description of earlier dictionaries and glossaries in our field, see my column in M/R, July 11, 1960.)

Industry

(Continued from page 16)

THOMPSON RAMO WOOLDRIDGE has established a new operating group, the Electronic Systems and Equipment Group. It will include the operating divisions formerly known as the company's Commercial Electronics and Intellectronics Groups. M. E. Mohr, vice president and formerly general manager of the Intellectronics Group, has been appointed General Manager of the new group. Divisions included in the group are Ramo-Wooldridge Division, TRW Computers Company, Dage Division, Educational Electronics, Bell Sound Division and Bel Canto Stereophonic Recordings Inc.

ATLANTIC RESEARCH CORP. has acquired a 15% interest in Nuclear Science and Engineering Corporation of Pittsburgh. Atlantic's president, Dr. Arch C. Scurlock, will be elected to the board of directors of Nuclear Science and Engineering. Atlantic Research recently expanded its electronics business by acquisition of Jansky and Bailey, Inc. of Washington, D.C., and Northeastern Engineering, Inc., of Manchester, N.H.

THIOKOL CHEMICAL CORP.'s Utah and Wasatch Divisions have now been combined in a single organization known as the Wasatch Division. Edward F. Nauman, formerly general manager of the Wasatch Division, has been appointed general manager of the combined facilities. John Higginson, formerly manager of the Utah Division, has been named manager of finance and administration for the unified operations.

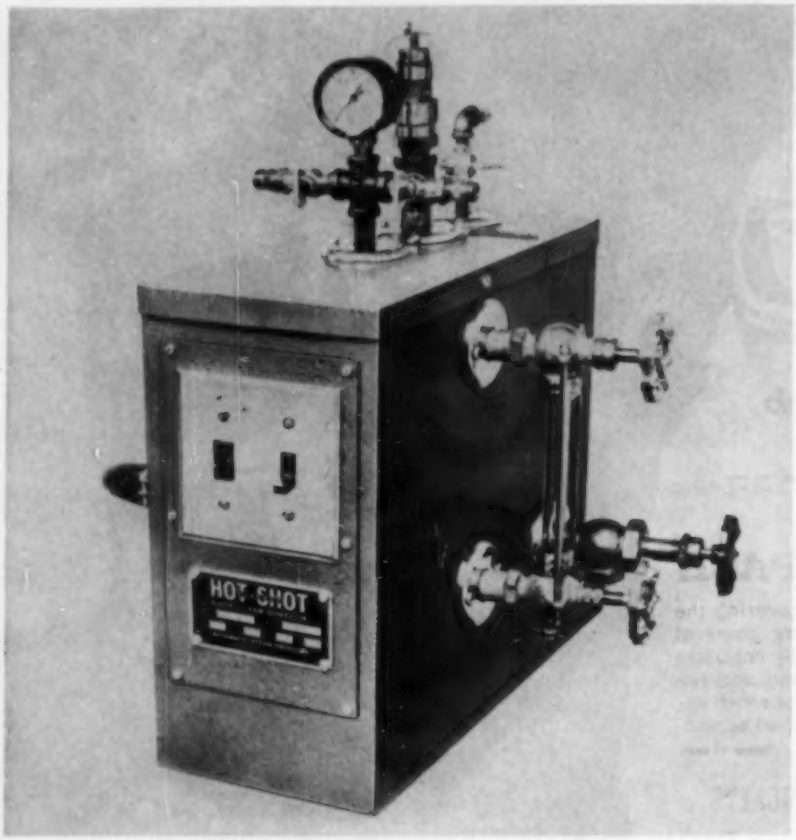
RADIATION TECHNOLOGY, INC., of Atlanta, will begin production on a number of all-transistorized instruments on June 1. The new firm is headed by James T. Bracken, formerly with Lockheed's Georgia Division.

CBS LABORATORIES has consolidated its activities in solid-state physics and promoted Dr. Wolfgang W. Gaertner to Vice President in charge of this area. The new Solid State Branch includes Semiconductor Research and Development, Surface Physics, and Memories and Subsystems.

BORG-WARNER CONTROLS has expanded its Meteorology/Oceanography operations based in Santa Barbara, Calif., adding several research and engineering specialists and additional facilities.

CHANCE VOUGHT CORP.'S new $3.5-million facility of the Electronics Division was officially opened recently. The 80,000-sq.-ft. building will house a completely autonomous electronics organization.

Research
And
Engineering
For
MAN IN SPACE
M/R's special issue covering the research and engineering phase of Man in Space is extremely important and timely... will be read and re-read by M/R's space-oriented audience of over 31,555* paid subscribers.
*Subject to audit.
MISSILES AND ROCKETS
MAY 29, 1961
Final Closing Date May 15
Materials
Boosters
Electronics
Space Medicine
Re-entry



Electronic Component Steam Cleaner

A completely automatic miniature electric boiler designed to be used in steam-cleaning small electronic components and assemblies is available from Automatic Steam Products Corp. The boiler fills a need where ultrahigh-quality steam is required to clean sensitive materials, or where components must be completely free of ferrous contamination.

All units are built to ASME specifications. Models are being used with regular tap water supply or with distilled water, depending on application.

Various horsepower models start at ⅓ BPH sizes and operational ranges are adjustable 0-100 PSI. The smaller units weigh less than 50 lbs., are completely portable and can be strategically placed in almost any part of the plant.

Circle No. 225 on Subscriber Service Card

Ceramic Diode Closure

A ceramic diode closure which meets the hermetic requirements of MIL specifications, and is suitable for thermal cycling between −65° and 150°C, is available in both standard and special sizes from Metalizing Industries, Inc.

The ceramic diode closure consists of a metalized ceramic shell, with a band of metal fired on to the inner edge at each end. The ceramic is L5 steatite. Two end caps are also supplied with each ceramic shell. The end cap is a nickel-iron-cobalt alloy .015 in. thick, clad with .003-in.-thick 60/40 solder.

Circle No. 226 on Subscriber Service Card

Damped Terminal

A lightweight terminal for mounting electronic components at high production rates is available from Pacific Coast Electronics Corp.

The Tri-El terminal is a formed stamping that mounts to a terminal board with a simple staking tool. In contract to ordinary two-element feed-through terminals, the Tri-El unit provides one connection on the top of the board, and two below. The availability of three connection points allows much greater flexibility. The terminal itself, since it is not a rigid post, will absorb vibration forces, greatly reducing the possibility of component failures.

The terminal exceeds requirements for vibration stability outlined in MIL specifications. Under test, a finished terminal board was checked in excess of 30 g's at frequencies from 5 to 2000 cps without showing any connection failure between terminals and components, or terminals and board.

Circle No. 227 on Subscriber Service Card

120° Aerial Mapping System

A 120° mapping projector is available from Bausch & Lomb, which plans to market it at about one-third the cost of comparable foreign-made instruments. In addition, the Balplex 120 is completely portable, for use either in headquarters or mobile field units, and has highest-quality precision optics protected by durable mountings.

The 120° aerial camera lens, developed in Europe, has made it possible to obtain greater area coverage in a single photo taken from the survey aircraft, cutting down on the number of flights over a particular region. In a similar fashion, the Balplex projectors allow mapping organizations to produce topographical maps from the aerial pictures with increased accuracy, economy of processing and field coverage.

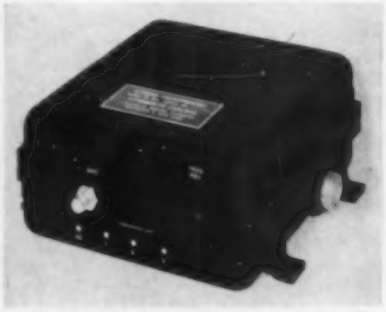
Circle No. 228 on Subscriber Service Card

Beacon Transponder

An advanced C-band beacon transponder which increases the reliability of radar tracking systems is available from Military Products Division of General Dynamics/Electronics.

Designed as a tracking aid for missile and high-speed aircraft applications, the transponder (Model SC-702) operates in the 5400-5900 megacycle frequency band, and responds to coded interrogations from radar such as the AN/FPS-16 and the AN/MPS-26. It can decode 38 different codes.

Circle No. 229 on Subscriber Service Card



Parabolic Antenna

Technical Research Group, Inc., Antenna & Microwave Dept., has available a 3-in.-diameter complete parabolic antenna for millimeter bands. The

antenna is available in V, E and F bands.

The miniature antenna has a 4.0° beam width at 70 KMC. This resolution is comparable to that of a 30-in. antenna at 7 KMC. The antenna is further rated at 22 db maximum side lobe; 32.9 db gain; 1 in. focal length. The antenna is designed for millimeter systems and antenna test applications.

Circle No. 230 on Subscriber Service Card

Traveling Wave Tube

A lightweight, compact, low-noise traveling wave tube featuring periodic permanent-magnet focusing is available from General Electric's Power Tube Department for operation in the 7000- to 11,000 megacycle frequency range.

The tube, type Z-3088, is suited for use as an input tube in airborne radar receivers and as a power amplifier in cascade chains.

The Z-3088 has a noise figure less than 15 db., with a minimum gain of 35 db., and minimum power output of 5 milliwatts over its designed frequency range.

Metal-ceramic construction gives the tube the ruggedness needed to withstand severe environmental conditions. The focusing magnets are temperature-compensated, and from −70° to 150° the change in magnetic field is less than 3%.

Circle No. 231 on Subscriber Service Card

Component Test System

A system that can accomplish production line or depot maintenance testing of electronic systems and components for about one-quarter the normal cost is available from Ortronix, Inc.

Designated the "Adept 400", the test equipment is a tape-programed unit capable of maintenance analysis and calibration of complete electronic systems and components. The unit permits automatic test by punch paper commands. It combines general testing capabilities with flexibility and can be custom-modified to fit any purpose desired.

Circle No. 232 on Subscriber Service Card

Directional Couplers

Sanders Associates, Inc. has introduced a line of precision made TRI-PLATE vairable directional couplers for strip transmission line circuits with coupling as tight as 2 db's. The devices, which have broadband applications, can perform as adjustable directional couplers, power dividers or variable attenuators with controllable power handling capacity and wide attenuation range. Within each frequency band three models are available with coupling at 3, 8, or 40 db.

Circle No. 233 on Subscriber Service Card

Induction Motors

Die-cast bearing brackets, with projections anchored in the field laminations, maintain rotor alignment during heavy shock in the Series M Shaded Pole Induction Motors available from Brevel Products Corp.

Used alone or as the backbone of a geared motor, the Series M is available in 4-stack thickness from 0.35 to 1.1 in., with maximum continuous duty torque ratings from 018 to 3 in.-oz. at 120 volts (1.3 to 11.5 in.-oz. during intermittent duty). No-load speed is approximately 3350 rpm.

Circle No. 234 on Subscriber Service Card

Accurate Writing Recorder

An 8-channel direct writing system, Recorder Mark 200, produces chart records of an accuracy and clarity never previously achieved by the direct writing method, according to its manufacturer, Brush Instruments, division of Clevite Corp. The unit is designed for use with analog computers but is equally suitable for general multichannel recording requirements.

Recording features include static and

dynamic accuracy of 0.5%, complete absence of overshoots, error-free rectilinear presentation, and a uniform nominal trace-width of 0.010 at all writing velocities.

Circle No. 235 on Subscriber Service Card

Magnetic Mixing Concentrate

A family of materials for the wet method of visible and fluorescent magnetic particle-testing is available from Magnaflux Corp.

The concentrates are all in powder form and incorporate features superior to the previous Magnaflux and Magnaglo pastes, including easier mixing, handling and storage; a measurable increase in fluorescent brilliance from 70% to 600%; closely controlled particle size range; less foaming, and more corrosion protection. The complete family consists of eight different materials.

Circle No. 236 on Subscriber Service Card

Transistorized Signal Tracer

In the absence of an oscilloscope, any low-level microwatt audio and modulated radio frequency signal can be detected or demodulated, then highly

amplified (approximately 1000 times) and reproduced through a high-quality earphone device at the output stage with a stethotracer available from Don Bosco Electronics.

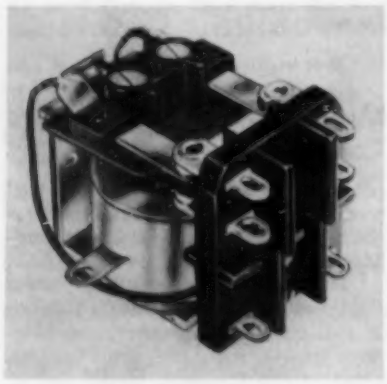
It enables all general-purpose laboratory oscilloscopes and instruments to detect low-level signals in the microwatt region. The output of the stethotracer is plugged into the scope by means of a specially designed adaptor plug (available optionally). The equivalent terminated impedance of the adaptor plug is 600 ohms; it will fit most of the laboratory scopes.

Circle No. 237 on Subscriber Service Card

Beryllia Heat Sinks Now Available Off-the-Shelf

Transistor dielectric heat sinks are available from National Beryllia Corp. Used to insulate semiconductor devices from the chasis, these heat sinks utilize beryllium oxide's ability to resist the flow of electricity but not the flow of heat, allowing higher power without exceeding temperature limits. Previously available only in small quantities made to order, Berlox beryllium oxide dielectric heat sinks are now available for immediate delivery from stock, at prices associated with high-quantity production.

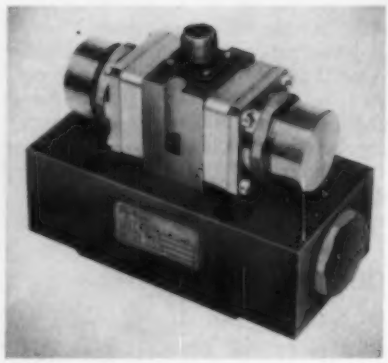
Circle No. 238 on Subscriber Service Card



Low Loss Relay

Artisan Electronics Corp. has available a ruggedized general-purpose relay, Model RF. The relay utilizes diallyl phthalate molded-plastic insulation that maintains insulating qualities and dimensional stability under severe environmental conditions. Thus, the RF Relay is dependable for general purposes and ideal for switching high-frequency current. The unit is compact in design, lightweight and economical.

Circle No. 239 on Subscriber Service Card



GSE Hydraulic Valve

A solenoid-operated hydraulic valve for ground support equipment or other critical control applications, which operates on both 115 volts a-c and 28 volts d-c without adjustment or coil changes, is available from Parker Aircraft Co. The high-performance valve permits operation on regular 60-cycle line current, and on emergency or portable battery power at a cost as low as single-voltage valves.

The valve assembly utilizes a solenoid-operated pilot valve and a heavy-duty slave valve designed for subplate mounting. Various flow sizes are available, depending upon the slave unit specified. All components are designed for operation at nominal system pressures up to 5000 psi, and have a life in excess of 5,000,000 cycles.

Circle No. 240 on Subscriber Service Card

Fiber Optic Printing

Direct optical printing at high speed on film and other types of light-sensitive materials is the result of a cathode ray tube utilizing fiber optic principles developed by Litton Industries.

The E1E11 is a miniature precision cathode ray tube with a face panel composed of a precision array of fiber optic light pipes. The individual light pipes are coated on the vacuum side with phosphor, which is excited by an electron beam emanating from a precision electron gun contained in the tube. By the use of digital deflection voltages a digital code can be generated in the face of this cathode ray tube.

Because the fiber optic light pipes conduct the light from the phosphor to the atmospheric side of the face plate without dispersion, the recording media can be placed immediately adjacent to the face of the cathode ray tube where the information is recorded without use of supplementary optical systems.

Circle No. 241 on Subscriber Service Card

Crystal Filters

Collins Radio Co. has available a line of crystal filters for a broad range of applications in single sideband.

Crystal Filters over the 10 kc to 30 mc frequency range are now being produced in quantities. One of the new units is a 5 mc filter in a thumbsize ⅜ in.^{3} case, less than half the package size previously available.

Circle No. 242 on Subscriber Service Card

Commutating Switches

A series of mechanical commutating switches known as the Deltaswitch Model 210 are available in one-pole and multi-pole configurations for communication of 64, and 100 channels of information from American Standard Corp. Designed for 20 cycles per second operation, these switches are available with or without 1200 rpm, 115 VAC, 60 cycle synchronous hysteresis drive motors.

A jet of mercury replacing the conventional wiper arm for commutation

assures long, trouble-free life and low maintenance expense, thus making Deltaswitch ideally suited to 24 hour per day—continuous operation. After commutating signals for well over 1000 hours, the Model 210 Deltaswitch is restored to like new condition by simply cleaning the switch parts and replacing the mercury.

Circle No. 243 on Subscriber Service Card

Power Transmission Duct

A high-frequency bus duct, for transmitting electrical power in frequencies from 180 to 20,000 cycles, is available from the Standard Control Division of Westinghouse Electric Corp.

With its use, a central powerplant can service an entire plant, with no need for small, individual high-frequency generators. Voltage drop is less than 1 volt per 100 feet at 400 cycles, based on an equally distributed load, line to neutral value, at the most unfavorable power factor.

Circle No. 244 on Subscriber Service Card

names in the news

KRAYBILL

BEAM

BEGOVICH

CATALDO

WICKHAM

Walter C. Scott: Appointed head of space power technology projects, Office of Space Flight Programs, National Aeronautics and Space Administration, Washington, D.C. Previously Scott was project engineer for the power system of the *Transit* navigation satellite, Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Md.

D. W. Kraybill: Former chief manufacturing engineer for the Astronautics Division, Chance Vought Corp., Dallas, appointed *Saturn* project manager.

William F. Mulcahy: Appointed director of manufacturing at National Semiconductor Corp., Danbury, Conn. Mulcahy formerly was with Hamilton-Standard Division of United Aircraft and RCA's Missiles and Surface Radar Division.

David H. Baker: Former president of Capital Airlines, Inc., elected vice president of Vickers Incorporated, Division of Sperry Rand Corp., Detroit, and general manager of its International Division.

Matthew J. Donachie: President, Metals Research and Manufacturing Co., Holyoke, Mass., elected to the board of directors of Beryllium International, Inc., Washington, D.C.

R. L. Beam: Elected executive vice president of Hazeltine Corp., Little Neck, N.Y. Beam also is a director of Hazeltine and executive vice president and operating head of the company's Electronics Division.

Dr. S. Fred Singer: Named a member of the board of directors of the Decker Corp., Bala Cynwyd, Pa. Dr. Singer, internationally-known astrophysicist, is professor of physics at the University of Maryland and a consultant to the government on space and missile programs.

Daniel E. Chaifetz: Vice president of Tech-Ohm Electronics, Inc., Long Island City, N.Y., elected president and chief executive officer.

Dr. J. Robert Downing: Former president of Space Recovery Systems, Inc., joins Standard Kollsman Industries, Inc., New York City, as technical director of advanced development at its Kollsman Instrument subsidiary. **Louis E. Sharpe** named associate technical director.

Dr. Donald B. Mackay: With North American Aviation's Space and Information Systems Division, awarded the Society of Automotive Engineers' Manly Memorial Medal for presenting 1960's best paper involving aerospace engine system.

Ernest D. Brockett: President of Gulf Oil Corp., elected to the board of directors, Westinghouse Electric Corporation, Pittsburgh.

Dr. Nicholas A. Begovich: Assistant manager of Hughes ground systems group and director of product line operations in Fullerton, Calif., appointed a vice president of Hughes Aircraft Co., Culver City.

Dr. Wolfgang W. Gaertner: Promoted to vice president in charge of solid-state physics, CBS Laboratories, Stamford, Conn. Formerly Dr. Gaertner was chief scientist of the Solid State Devices Division, U.S. Army Research and Development Laboratory, Fort Monmouth, N.J.

Alvin M. Weinberg: Director of Oak Ridge National Laboratory, elected a member of the Physics Section of the National Academy of Sciences.

John G. Sinclair, Jr.: Joins Microwave Laboratories, Quantatron, Inc., Santa Monica, Calif., as senior engineer. Prior to joining Quantatron, Sinclair was with Hughes Nuclear Electronics Laboratory.

Ronald Hendricks: Named manager of systems engineering at Link Division of General Precision, Inc., Binghamton, N.Y. Previously Hendricks was associated with General Electric's *Nimbus* satellite program.

Frederick E. Hines: Former vice president-finance of Douglas Aircraft Company, elected to the Electronic Engineering Company of California board of directors.

Carl J. Stauff: Appointed director of field engineering for Photo-Optical Division of Consolidated Systems Corp., Monrovia, Calif. Stauff previously was director of government sales at Bell & Howell Co.

Stuart M. Hauser: Former chief engineer, named assistant general manager for operations of Electro-Optical Instruments, Inc., Pasadena, Calif.

M. W. Medley: Named chief contract negotiator for Product and Industrial Engineering Corp., subsidiary of Space-Tone Electronics Corp., Washington, D.C. Prior to joining PIECO, Medley was sales engineer for Vitro Engineering Co., New York City.

J. T. Cataldo: Corporate vice president of International Rectifier Corp., El Segundo, Calif., appointed executive vice president and general manager of the company's subsidiary, Dallons Laboratories, Inc., Los Angeles.

Dr. Cameron Knox: Appointed corporate director of research for Acoustica Associates, Inc., Los Angeles. Previously Dr. Knox served as colonel with the Joint Chiefs of Staff, Washington, D.C.

C. S. Brown: Named division manager of newly formed Missile Plastic Division of H. I. Thompson Fiber Glass Co., San Rafael and Inglewood, Calif. **Don Hatch** named technical engineering consultant.

Dr. Donald Wickham: Formerly with Lincoln Laboratory, Massachusetts Institute of Technology, appointed manager, Material Research and Development, Ampex Computer Products Co., Components Division, Culver City, Calif.

Thomas I. Harkins: Promoted to manager of purchasing and contracts for Sylvania Electronic Systems, Waltham, Mass.

Marjorie R. Hyslop: Appointed manager of the American Society for Metals Documentation Service. Previously Mrs. Hyslop was managing editor of *Metal Progress*. Other ASM appointments are: **Taylor Lyman,** editor of reference publication, and **Dr. Allen Gray,** editor of periodical publications.

contracts

NASA

$4,800,000—Aetron, Covina, Calif., Division of Aerojet-General, for final design of *Saturn* static test facility and procurement and fabrication of technical systems and instrumentation for the facility.

$97,631—Systems Division of Beckman Instruments, Inc., Anaheim, Calif., for design, development and fabrication of Doppler data acquisition and processing equipment.

$41,956—The Budd Co., Space Atomics Division, Philadelphia, for pressure vessels for Lewis Research Center.

United Technology Corp., Sunnyvale, Calif., for design, fabrication and test-firing of a flight-weight conical, segmented, solid-propellant rocket motor of 250,000 lbs. thrust. No amount disclosed.

MISCELLANEOUS

$54,288—Drexel Dynamics Corp., Philadelphia, for Aero 16B missile skids.

Capehart Corp., Richmond Hill, N. Y., from **United Aircraft Corp.,** Windsor Locks, Conn., for evaluation of radio frequency interference at proposed missile components test site. No amount disclosed.

NAVY

$4,500,000—General Electric Ordnance Dept., Pittsfield, Mass., for Mark 1 inertial guidance systems for the *Polaris* missile.

$2,500,000—Philadelphia Gear Corp., King of Prussia, Pa., from **General Dynamic's Electric Boat Division,** for gear drives for the 600-ft. radio telescope at Sugar Grove, W. Va.

$1,000,000—Electronic Specialty Co., Stamford, Conn., for ASW sonar high-voltage rotating power supplies.

$296,000—Computer Systems, Inc., Monmouth Junction, N. J., for four 5800 Dystac iterative analog computers to aid in design and development of high-speed hydrofoils.

$125,000—Automation Industries, Inc., Manhattan Beach, Calif., from **Hercules Powder Co.,** for study and development of new ultrasonic methods of inspecting an entire solid-propellant missile system.

$100,000—Electronic Specialty Co., Stamford, Conn., for equipment to be used in electronic checkout system for the *Polaris* missile submarine program.

$99,349—Lockheed Aircraft's Missile and Space Division, Sunnyvale, Calif., for study of the effects of ultrahigh nuclear detonations.

$85,294—Vought Electronics Division of Chance Vought Corp., Arlington, Tex., for C-band radar beacon, superhetrodyne.

$82,283—Beech Aircraft Corp., Wichita, Kan., for spare parts, materials, and equipment for target drones.

Associated Testing Laboratories, Inc., Wayne, N. J., for reliability evaluation testing of components of the *Polaris* missile. No amount disclosed.

ARMY

$2,500,000—Collins Radio Co.'s Alpha Corp., Dallas, for modification of Signal Corps tracking station at Richardson, Tex.

$1,900,000—Radioplane Division of Northrop Corp., Van Nuys, Calif., for target missile production, flight services and engineering services. (Three contracts).

$1,636,395—Douglas Aircraft Co., Inc., Santa Monica, Calif., for guided missile trailers; $84,676 for *Nike* missile system spare parts and launching area items.

$1,162,253—Philco Corp., Philadelphia, for fuzes for the *Sergeant* missile.

$485,799—McCulloch Corp., Los Angeles, for target missile engines and engineering services. (Two contracts).

$437,969—Western Electric Co., New York City, for *Nike-Hercules* warhead body assembly kits with shipping containers. (Two contracts).

$305,272—Berkeley Pump Co., Berkeley, Calif., for pumps for *Titan II* missile launch facilities.

$201,854—Greer Hydraulics, Inc., Los Angeles, for hydraulic components for blast doors and blast dampers with auxiliary equipment for *Titan II* missile launch facilities.

$117,280—Gilfillan Brothers, Inc., Los Angeles, for *Corporal* missile spare parts and telemetry equipment.

$96,589—Worthington Corp., Los Angeles, for air compressors for *Titan II* missile launch facilities.

$92,377—Darco Industries, Inc., El Segundo, Calif., for entrapment television system for *Titan II* missile launch facilities.

$89,435—Associated Aero Science Laboratories, Hawthorne, Calif., for technical instructions at Redstone Arsenal.

$76,661—Monsanto Research Corp., Everett, Mass., for a study on anti-radiation drugs.

$65,338—Quinco Electric Co., Inc., Orlando, Fla., for construction of instrumentation sites for Complex 34, Cape Canaveral Missile Test Annex, Patrick AFB.

$54,458—Consolidated Western Steel, Los Angeles, for *Nike* missile repair parts.

$39,295—Fenwal, Inc., Ashland, Mass., for fire detectors for *Titan II* missile launch facilities.

AIR FORCE

$9,000,000—The Hallicrafters Co., Chicago, for logistic support items for airborne electronic countermeasure equipments.

$1,500,000—North American Aviation, Inc., Space & Information Systems Div., Downey, Calif., for *Hound Dog* mobile training unit trainers.

$1,300,000—Electronic Communications, Inc., St. Petersburg, Fla. for aerospace-ground equipment for *ALRI*, the airborne extension of *SAGE*.

$974,233—Page Communications Engineers, Inc., Washington, D.C., for modification of communications systems. (Two contracts.)

$822,098—Radiation at Stanford, Palo Alto, Calif., for design, development, construction, installation and testing of radar communication transmitter.

$750,000—Royal Industries, Inc., Los Angeles, from **Hughes Aircraft Co.,** for specialized containers for the *Falcon* missile.

$728,983—Hughes Aircraft Co., Fullerton, Calif., for radar tracking station.

$600,000—American Electronics, Inc., Los Angeles, from **Boeing Airplane Co.,** for power units for *Minuteman* ICBM, $160,000 from **Boeing** for constant voltage type power supplies for *Minuteman*.

$250,000—Servo Corp of America, Hicksville, N.Y., for development of specialized multi-channel radio receiver for Cape Canaveral tracking station.

$188,340—Boeing Airplane Co., Aero-Space Div., Seattle, for helium tank assemblies for *Bomarc* weapon system.

$137,105—Convair (Astronautics) Div., General Dynamics, San Diego, for seven Azusa transponders and checkout sets.

$99,528—Hughes Aircraft Co., Culver City, Calif., for research in the application of new techniques applicable to recognition of non-cooperative aerospace vehicles.

Electro Development Corp., Seattle, from **Aero-Space Division of Boeing Airplane Co.,** for separation sensing devices for the *Minuteman* ICBM. No amount disclosed.

Spacelabs, Inc., Van Nuys, Calif., for design of a system for continuously measuring space crewmember blood pressure. No amount disclosed.

REQUESTS

The NASA Procurement Office, Marshall Space Flight Center, Huntsville, Ala., has issued a request for Proposal TP 82-227, for 105-in. Oxidizer Containers for the S1 Stage of *Saturn*. The quantity is six each.

The procurement involves extensive facilities (i.e., Hydrostatic Test Arrangement, Cleaning Equipment, Mechanical and Chemical Milling, and welding of sheet aluminum into 105-in. diameter segments).

The units are flight components for *Saturn* booster and rigid reliability, quality assurance, testing and processing specifications are applied. These 105-in. oxidizer containers are cylindrical in shape, have rigid-wall-type structural design, and consist primarily of welded skin segments, spin-forged heads, longerons, stiffeners, manifolds, angles, tubing, and baffles.

The containers are 105 inches inside diameter, approximately 675 inches long, and weigh approximately 6272.776 pounds each. The milled skin segments are fabricated from Type 5456-H343 Aluminum Alloy Sheets, thickness 0.249 to 0.305 inches (unmilled).

Tooling and production layout must be ready by Jan. 1, 1962, with container deliveries commencing Apr. 1962. Proposals are due to be received at the NASA Procurement Office, George C. Marshall Space Flight Center, Huntsville, Ala. (Attn: M-P&C-C), by June 1, 1961.

The following firms have been invited to participate at conference and proposed for prime contract—Boeing Airplane Co., Aero-Space Div., Seattle, Wash.—Chance Vought Corp., Vought Astronautics Div., Dallas, Tex.—Chrysler Corp., Missile Div., Detroit, Mich.—Douglas Aircraft Co., Inc., Santa Monica, Calif.—Lockheed Aircraft Co., Georgia Div., Marietta, Ga.—The Martin Co., Baltimore, Md.—McDonnell Aircraft Corp., St. Louis, Mo.—North American Aviation, Inc., Missile Div., Downey, Calif.

NASA suggests that small business firms or others interested in subcontracting opportunities on this procurement make direct contact with the above firms.

when and where

MAY

National Aeronautical Electronics Conference, IRE, Miami and Biltmore Hotels, Dayton, Ohio, May 8-10.

Fifteenth Annual Power Sources Conference, sponsored by U.S. Army Signal Research and Development Laboratory, Shelbourne Hotel, Atlantic City, N.J., May 9-11.

Western Joint Computer Conference, American Institute of Electrical Engineers, Institute of Radio Engineers, and Association for Computing Machinery, Ambassador Hotel, Los Angeles, May 9-11.

Society for Experimental Stress Analysis, Benjamin Franklin Hotel, Philadelphia, May 10-12.

National Armed Forces Day Dinner, sponsored by Navy League, The Military Order of the World Wars, and the Air Force Association, Sheraton Park Hotel, Washington, D.C., May 12.

British Interplanetary Society, Symposium on Communications Satellites, London, May 12.

Institute of Radio Engineers, Professional Group on Microwave Theory and Techniques, National Symposium, Sheraton Park Hotel, Washington, D.C., May 15-17.

Society of Aeronautical Weight Engineers, National Conference, Sheraton Hotel, Akron, Ohio, May 15-18.

ARS National Telemetering Conference, Sheraton Towers Hotel, Chicago, May 22-24.

Fifth Global Communication Symposium (Globecom V) and National Telemetering Conference, sponsored by American Institute of Electrical Engineers, Institute of Radio Engineers, Institute of the Aerospace Science and Instrument Society of America, Sherman Hotel, Chicago, May 22-24.

Design Engineering Show, Cobo Hall, Detroit, May 22-25.

Society of Automotive Engineers, Military Ground Support Equipment Committee, Continental Hilton Hotel, Mexico City, Mexico, May 23-25.

Operations Research Society of America, Ninth Annual Meeting, Sheraton-Blackstone Hotel, Chicago, May 25-26.

Chemical Institute of Canada, Forty-fourth Annual Meeting, Ottawa, Canada, May 29-31.

7th Annual Radar Symposium (SECRET), University of Michigan, Institute of Science and Technology, Ann Arbor, May 31-June 2.

JUNE

National Machine Tool Builders' Association, 59th Spring Meeting, Mayflower Hotel, Washington, D.C., June 1.

American Society for Quality Control, Annual Convention, Sheraton Hotel, Philadelphia, June 5-7.

International Instrument Automation Conference and Exhibit, Instrument Society of America, Royal York Hotel, Toronto, Canada, June 5-8.

National Electrical Manufacturers Association, Western Conference, Biltmore Hotel, Los Angeles, June 8-9.

Manufacturing Chemists Association, 89th Annual Meeting, The Greenbrier, White Sulphur Springs, W. Va., June 8-10.

European Federation of Chemical Engineering, Thirtieth Meeting, Frankfurt-am-Main, Germany, June 9-17.

American Society of Mechanical Engineers, Statler-Hilton Hotel, Los Angeles, June 11-15.

Third National Symposium on Radio Engineers, Inc., Sheraton Park Hotel, Washington, D.C., June 12-13.

Instrument Society of America, 3rd International Symposium on Gas Chromatography, Michigan State University, East Lansing, June 13-16.

Joint ARS-ISA Meeting, Ambassador Hotel, Los Angeles, June 13-16.

Applied Mechanics Conference, American Society of Mechanical Engineers, Illinois Institute of Technology, Chicago, June 14-16.

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editorial . . .

The Debacle at Cape Canaveral

WE MUST CONFESS that the tremendous publicity buildup for the suborbital *Mercury* shot left us cold, a condition marked by a shiver at the spectre of failure which hovered all too close in the background.

With a courageous astronaut risking his life for what in final analysis had become a circus stunt, the sight of unknowledgeable television announcers assuring the American public that this was a "great day in American history," a day the first American was to "go into space," was nauseous.

On one network show, the announcer asked his blonde colleague what she thought of this great day in American history and was rewarded with several inane remarks, followed by a dogfood commercial.

This is not to question the courage and dedication of the Project *Mercury* team, the technical achievements of the program or the genuine accomplishments of the contractors involved. It is to question the wisdom of the public relations approach to the shot.

To permit the effort to be turned into a Roman spectacle was at the very least in the worst possible taste—and at most an appalling display of ignorance of its effect on world opinion.

Scheduling of the shot was an effort to beat the Russians to manned space flight, although it appeared to us from the beginning to be more of an altitude record attempt than any significant space accomplishment. With Soviet Maj. Gagarin's accomplishment of a true orbital flight, the suborbital *Mercury* shot lost any propaganda value it may initially have had. With so little to gain from a scientific standpoint, it should have been scrubbed. This lack of significance was buried in an emotional frenzy.

Throughout last week's countdown, there persisted the boyhood memory of the "Human Cannonball" in the circus, waiting to be fired out of the big gun and across the arena into a net before the eyes of horrified paying customers. Aside from altitude, the objective was similar and the atmosphere the same. Hurry, hurry, hurry, the big show is about to start.

THE BLAME for this debacle of second-bestmanship rests squarely on the Kennedy Administration.

We are not alone in this belief. Sen. Williams of Delaware told the Senate last Monday, the day before the shot was postponed for the first time:

"Administration officials responsible for this project are so confident of its success that they have spent the last 10 days in announcing to the world what a great achievement they expect to accomplish this week at Cape Canaveral. Approximately 500 reporters and photographers from all over the world have been invited there to witness the success of the first Yank-in-space project. I fail to find where any thought has been given to what effect this tremendous buildup will have upon the American prestige should the attempt be a failure."

Sen. Williams said he had suggested to the Administration that it cancel the suborbital shot and reschedule it for a future, undisclosed date. He added: "Then when this project is rescheduled, it should refrain from any publicity until after it has actually been attempted."

To anyone familiar with missiles, this made good sense. It is now too late to do anything about the suborbital shot. But we suggest the Administration study carefully what has taken place and begin planning now to avoid its recurrence in connection with the orbital *Mercury* shot.

We are not suggesting the orbital shot be closed to the press. But a great deal can be done to eliminate the revolting display to which we were treated last week.

William J. Coughlin

The pilot is inside, flying over enemy lines.

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